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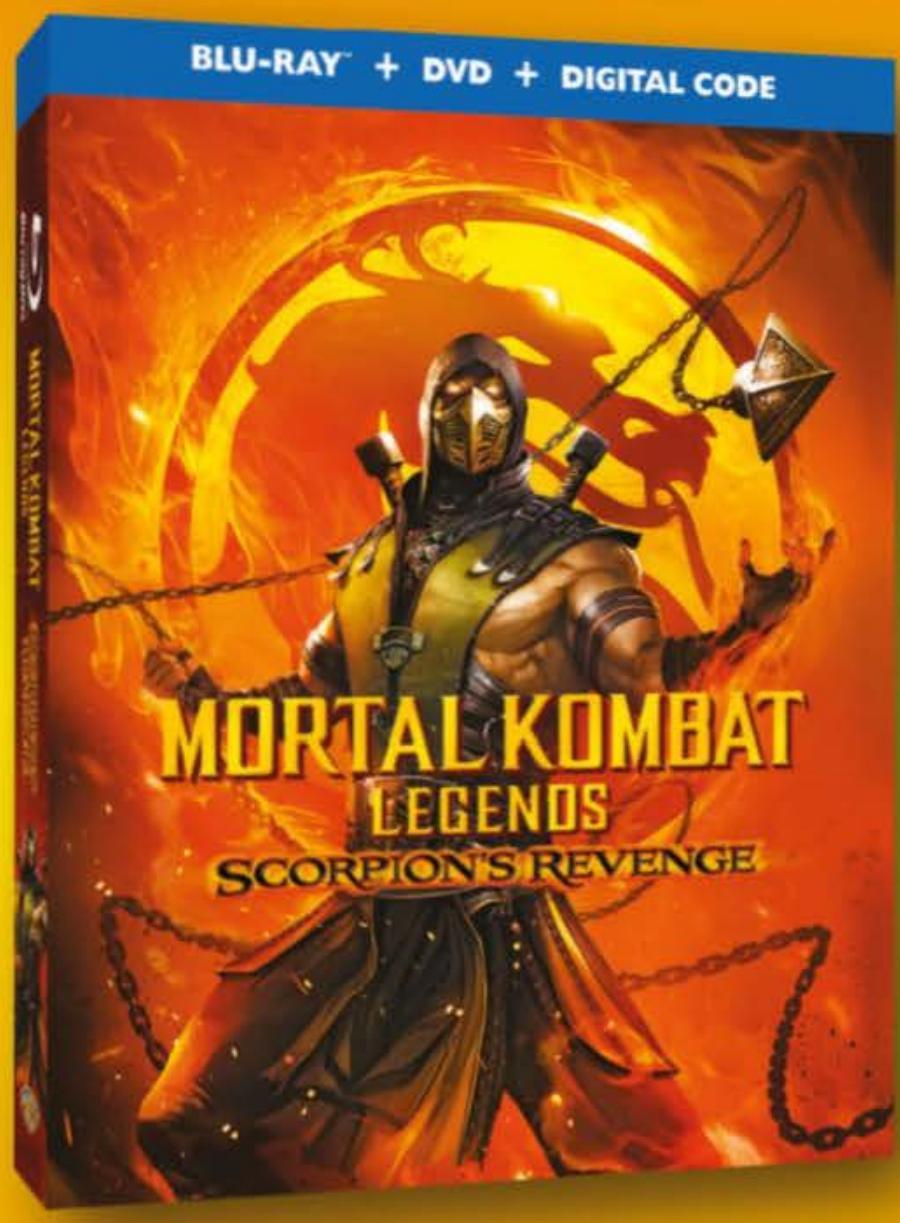

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Copy Editor: Katharine Davies
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ART
Art Editor: Fraser McDermott
Photography: Neil Godwin, Olly Curtis, Phil Barker
Cover Photo Credits: AMD, Alienwear, Nvidia, Future plc

BUSINESS
US Marketing & Strategic Partnerships: Stacy Gaines, stacy.gaines@futurenet.com
US Chief Revenue Officer: Luke Edson, luke.edson@futurenet.com
East Coast Account Director: Brandie Rushing, brandie.rushing@futurenet.com
East Coast Account Director: Michael Plump, michael.plump@futurenet.com
East Coast Account Director: Victoria Sanders, victoria.sanders@futurenet.com
East Coast Account Director: Melissa Planty, melissa.planty@futurenet.com
East Coast Account Director: Elizabeth Fleischman, elizabeth.fleischman@futurenet.com
West Coast Account Director: Austin Park, austin.park@futurenet.com
West Coast Account Director: Jack McAuliffe, jack.mcauliffe@futurenet.com
Director, Client Services: Tracy Lam, tracy.lam@futurenet.com

PRODUCTION
Head of Production: Mark Constance
Production Manager: Vivienne Calvert
Project Manager: Clare Scott
Production Assistant: Emily Wood

FUTURE US, INC.
11 West 42nd Street, 15th Floor, New York, NY 10036, USA
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Tel +44 (0)1225 442 244

Alan Dexter

IT'S NOT YOU, IT'S ME...

THE PC INDUSTRY as a whole is in a constant state of flux, so it shouldn't come as much of a surprise that the staff at your favorite magazine (that'll be the one you're holding right now) changes regularly, too. Hopefully, it won't come as too much of a shock when I reveal that this is my final issue as editor. I've loved working on this magazine, but as the saying goes, all good things must come to an end.

There have been some pivotal releases during my tenure, and I've mentioned some of those in my "Lab Note" at the back of the magazine, but the real highlight has to be the people I've worked alongside—both the staff who work hard to put each magazine together, and the army of freelancers we call upon to write the features, news, reviews, and tutorials. There are some incredibly talented people who help put this magazine together, and it's these guys and gals that I'll miss more than the piles of tech I leave cluttering up the hardware cupboard.

Then there's you, the readers. I've worked across many magazines over the years, but none of them have had a readership like *Maximum PC*. Your letters and emails reveal an incredible passion and knowledge that I'll miss. You keep the magazine vibrant, ensure that we're covering the things you're interested in, and come up with wild and wonderful ideas for features and tutorials alike. Long may you keep reading, and keep writing in and letting us know what we are doing right, and what we're doing wrong.

There's plenty of knowledge in the pages you're holding as well. This issue we set ourselves the task of speeding up Windows 10, while also keeping a watchful eye out for optimizations and tricks that do little or absolutely nothing, and call them out if we feel they're not worth spending time on. Windows 10 is an evolving beast, and there are bound to be a few settings that you're unaware of as you read the main feature on page 24.

Elsewhere, we take a look at what's happening with Nvidia's DLSS technology, which has recently enjoyed an update that improves performance significantly, but at what cost to visual fidelity? We also show you how to do more with the Linux terminal, which is useful if you've taken to experimenting with the support for Linux within Windows 10. The build this month looks at piecing together a machine for LAN parties. Plus, we have plenty of tutorials and reviews to get your teeth into. It's a packed issue. Once again.

What about my replacement, I hear you cry? I'll leave that surprise to the next issue, although I will say that it's a face you'll already be familiar with. I hope you'll join me in welcoming them back to the magazine, and I wish them, and all of you, the very best for the future.

Alan Dexter is Maximum PC's *executive editor and a punisher of hardware. He's been a tech journalist for over 20 years, and has no problem upsetting the PC industry as a whole.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

Comet Lake Reaches the Desktop

Now with more cores and a little bit faster

JUST WHEN YOU thought Intel couldn't push its aging 14nm Skylake microarchitecture any further, it does it again. AMD's speedy Zen chips have left Intel little choice but to respond. The slow development of its 10nm Sunny Cove parts means, once again, it's down to old faithful to fill the gap, now on its fourth refinement. Luckily, Skylake has proved its worth, and Intel is getting good at squeezing every drop out of it. Not that there is much juice left. Each iteration gains over the last by a lesser degree.

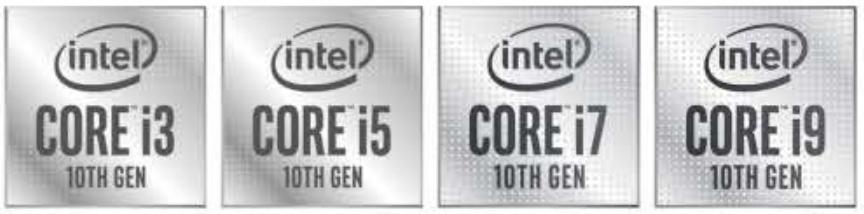
Comet Lake first appeared last year, disappointing us by only being low-power U series chips. Now we get the full-on S desktop and H laptop versions. Exact specs haven't been officially announced, but there are engineering and qualifying samples about, along with enough slides and leaks to piece things together. There will be a full range of parts, essentially replacing the existing ninth-generation chips with 10th-gen parts, from the i3-10100 upward. There are a few upgrades, every chip gets HyperThreading, and there are a few (modest) speed hikes for boost modes. There's no PCIe 4.0 support, though.

At the top of the tree will be the Core i9-10900K, with 10 cores, a base clock of 3.7GHz, 20MB of cache, and a maximum boost clock of 5.3GHz. The speed is thanks to Intel's Thermal Velocity Boost, which makes use of every bit of the thermal envelope you have. This speed isn't guaranteed; it has an all-core boost of 4.8GHz, and a Max Turbo boost of 5.1GHz otherwise, making the i9-10900 6 percent faster (under ideal conditions), and with two more cores over the current speed champion, the 5GHz i9-9900K. It has a quoted TDP of 125W, but under load it can reportedly more than double this. There's a number of F-series chips listed, too. These have had the integrated graphics deactivated. Early benchmarks have been mixed, but testing engineering samples isn't always reliable. We will have to wait for stable systems and more reliable testing (that's us).

You won't be slotting these 10th-gen chips into your rig, though. We have a new socket standard: LGA 1200, with an extra 49 pins for power and I/O (more cores require more pins). A new socket also means a new motherboard chipset, in this case a 400-series Z490, B460, or H470. These are all ready to roll; the motherboard manufacturers have been waiting for the processors. Apparently, the bulk of the Comet Lake range has been ready for a while, but getting the fastest "halo" version running smoothly has delayed things. It's the star performer that makes the headlines, so we've all had to wait.

One easy way to be competitive is to be cheaper. Leaked price lists show Intel is sticking pretty much to its existing structure—the 10th-generation parts will cost the same as the equivalent ninth-gen parts. Some pundits say that Intel is planning a round of reductions, but we've heard that before and nothing transpired. It's unlikely that there will be much change. Supply is tight, and if you're selling everything you make, there's little incentive to sell it for less. Intel will cut prices when the heat is on. It recently took a chainsaw to a lot of its server and X-series parts, thanks largely to Threadripper's growing share, but it takes more market pressure than there is in the desktop sector for that yet. So, expect that 10-core beast to be expensive.

We should see the new chips before the end of the summer, possibly even spring. Intel is having a hard time matching AMD across most of the market, but however fast Ryzen gets, Intel manages to make a chip that can, right at the limit, be faster. For many, that's all the reason they need. Reaching 5.3GHz is probably pushing the design about as far as it can go, requiring trickery with boosts and quite probably liberties with binning and cooling. Intel will probably still make the fastest gaming chip, but it's on the back foot on just about every other metric. Intel's chip generations are clearly marketing fluff—this Comet Lake range looks suspiciously like a slightly overclocked set of ninth-gen chips. It's better than nothing, though, and that 5.3GHz figure will grab the headlines. **–CL**



> 5.3GHz is probably pushing the design as far as it can go.

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PELOTON BRICKS BIKES

Internet of Things has a problem

IF YOU HAVE a Flywheel exercise bike, you'll have noticed it has stopped doing all the fancy Internet functions—no more live streaming classes at home. Flywheel launched its Peloton rival in 2017, and has an avid following. However, it has lost a case of patent infringement with Peloton, which claimed that Flywheel had copied its Leaderboard, where users are ranked against—which it had. After that, the service was no more. Peloton is offering some comfort: It's offered to swap your Flywheel bike for a refurbished Peloton one. You're out of luck if you bought your bike with finance, though, in which case you now own a rather expensive ordinary exercise bike. Flywheel still runs studio sessions, but the at-home service is dead.

This isn't an isolated event. Earlier in the year, cable company Charter decided it didn't want to run its Spectrum smart home security service any more, so switched it off, and walked away. All its devices were proprietary, so everything was dead, leaving your house dotted with dumb sensors and cameras. Customers were offered discounts on similar products from Amazon or Adobe, but nothing like a full refund. Last December, Sonos bricked speakers destined to be upgraded, much to people's annoyance, as they had to throw away perfectly good gear. In 2017, Logitech killed its Harmony Link service unless you upgraded, and a year later it bricked those upgrades if they connected to other devices. In 2014, Google killed Revolv's smart home hub, after it bought the company two years earlier. Occasionally, it gets personal; a Garadget smart garage doors customer left an unflattering online review, and found his service suspended.

As an increasing number of devices get connected, you become vulnerable to the whims and fortunes of the companies you bought them from. Hardware comes with a warranty, Internet services do not. **–CL**

BIG NAVI RUMORS

IT IS, INDEED, GOING TO BE BIG

AMD'S CEO CONFIRMED THAT AMD is bringing out its "Big Navi" card this year, based, we assume, on the second-gen Radeon DNA, which is also appearing in the new Xbox and PS consoles. With no firm announcements, we have to turn to rumor and leaks. One such (convincing) leak has an as-yet unannounced Radeon RX 5950 XT having 5,210 shading units, 80 compute units, 320 texture mapping units, 96 render output units, and 24GB of memory on a 4,096-bit bus. Compare this to the current heavyweight, the Radeon RX 5700 XT, where you can halve those numbers. Apparently, it has just passed RRA certification, which points to an early release. There will be lesser kin, too: the Radeon 5950, 5900, and 5800 XT.

What the new card won't be is affordable. If it does pack that much high-bandwidth memory, the retail price is going to be alarming, so start saving now. Nvidia has been at the top of the graphics card pile for a while now, but AMD is nothing if not ambitious, and is on something of a roll at the moment. Expect new benchmarks to be set. **–CL**

SECURITY DOH

Mozilla enables controversial new encryption

MOZILLA'S FIREFOX BROWSER is to be the first to enable encrypted DNS over HTTPS (DoH). The roll-out should be nearly done now. Mozilla claims "unencrypted DNS is not only vulnerable to spying but is being exploited." Chrome is scheduled to make a similar move. DoH disguises DNS enquiries as regular traffic, sending them to "resolver" servers, which unscramble and return the encrypted result. It's claimed to help stop ISPs tracking you, and be a way to bypass censorship.

"Security experts" claim DoH can't properly prevent tracking; there are dozens of other data points for this, not least the IP address. It's also going to be a pain for IT departments, where it bypasses DNS filtering systems, making spotting DNS hijacking next to impossible. Last summer, the first malware to exploit DoH emerged, and there have been dire warnings of more before security systems catch up. The Firefox settings are under "Network," where you can pick a resolver, or disable it if you have doubts. **–CL**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

WOW WOWS
World of Warcraft Classic has lead to a doubling of paid *WoW* subscribers since launch. Not bad for a 15 year-old game.

GTA IV BACK ON STEAM
A notable absence from Steam, *GTA IV* is finally on board as a new Complete Edition, but with no multiplayer or leaderboards.

WIN 10 GETS 3D ICONS
Win 10X is first to get the new Fluent Design icons. The rest of us will be updated soon.

TRAGEDIES

SMART PET FEEDER FAIL
A system outage at Petnet left its Gen2 SmartFeeders unresponsive to the app, leading to some grumpy cats.

MICROSOFT BACKS DOWN
After threatening Office users with having to use Bing, Microsoft listened to protests and offered it as an opt-in.

RADEONS GO BLACK
AMD has problems with its latest driver, leaving some people looking at nothingness.

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Encryption Under Legal Threat

US CONGRESS IS LOOKING AT RESTRICTING the use of end-to-end encryption. The bill responsible goes by the title of Eliminating Abuse and Rampant Neglect of Interactive Technologies Act, or EARN IT. The goal is cited as stopping the exploitation of children online, which is hard to argue against, but the ramifications are far wider. Currently, Facebook and friends escape responsibility for the nefarious acts of users, thanks to Section 230 of the Communications Decency Act. This absolves them of responsibility, even for the most heinous of crimes; they are merely "providers." This infuriates many lawmakers, who see the distributors of abusive material go unpunished. They also perhaps don't relish the privacy that encryption provides.

If passed, the Act would force tech companies to use "best practices," which earn their immunity under Section 230. A new commission will recommend best practices to the Attorney General, who would retain the final decision. An obvious target is end-to-end encryption; with this in place, it is next to impossible to police material. Thus, without specifically banning encryption, companies would have to drop it to earn immunity. There's a number of problems with the bill, not least of which is that it is potentially unconstitutional. It is also unlikely to have much effect. You could, for example, encrypt something, then distribute it. EARN IT is legally flawed, and unlikely to become law. It's a clumsy attempt to strip Section 230 immunity from technology companies, and police how they operate, but it won't be the last. **–CL**

The bill's sponsors include Senators Lindsay Graham and Richard Blumenthal.

The CIA Was Listening

For years, world governments used encryption machines provided by Swiss specialist Crypto AG to send diplomatic secrets. What they didn't know was that Crypto AG was owned by the CIA and the BND, the West German intelligence service. It was secretly purchased in 1969, and until its demise in 2018, the CIA had access to supposedly secure encrypted information (the Germans pulled out in the 1990s). Russia and China didn't use the equipment, but many did, including Iran, India, South American juntas, and the Vatican. This Cold War secret has come to light thanks to newly declassified documents. The CIA and BND have made no public comment. **–CL**

Facebook Faces $9 Billion Tax Bill

The IRS has taken Facebook to court in San Francisco, claiming the company owes $9 billion in unpaid taxes, plus interest and sundry penalties. The trouble dates back to the start of Facebook's international expansion in 2010. It used a company abroad to sell intellectual property (IP), on which royalties were collected, all in a nice low-tax environment. Legal, but questionable. The IRS claims the company undervalued the IP it sold to the subsidiary. Facebook claims the low valuations reflected the risks it was taking. The trial should take about a month. It's a big bill, roughly a year's worth of Facebook's profits, or a fifth of its cash reserves. **–CL**

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MORE CONSOLE TEASING

Tech specs shaping up

WHILE WE WAIT for the next generation of consoles, Microsoft and Sony are keeping us interested with a trickle of teasing specifications. And it's good stuff. We now know the new Xbox's GPU is based on AMD's RDNA 2 architecture and pumps out 12 teraflops of GPU power. That's about twice as fast as the Xbox One X, faster than a GeForce RTX 2080 Super, and not far behind an RTX 2080 Ti.

We knew it was going to be fast, but what else? A new console often means binning games—no more. The new Xbox will be compatible across four generations of Xbox, right back to the original machine. Your old games will load faster, run faster, and with improved visual fidelity. Xbox Game Studios titles will use Microsoft's new Smart Delivery, which will enable you to play the same game on any compatible box. *Halo Infinite,* the launch title, will support the current and the new Xbox. There's a new "quick resume" feature, which will enable you to resume multiple games from suspended states. There are also strong hints of dedicated audio hardware, with "3D" sound that appears to be coming at you from all directions.

Meanwhile, Sony has registered patents that point to the addition of biofeedback. The patent describes having sensors in the controller that monitor heart rate and electrodermal activity (sweat). What game developers make of this remains to be seen. Another Sony patent describes a gaming coach that provides players with contextually relevant information; you ask a question, and the cloud-based AI does the rest. Sony's CEO, Jim Ryan, has said that there are "bigger differences" coming with the PS5, so Sony has a trick or two still to reveal. However, it's having trouble keeping the price of the PS5 down, with a current reported build cost of $450 a pop. It won't be alone here—both machines are packed with solid state memory, which is notorious for its erratic pricing. We can expect both consoles to land before the end of the year. **–CL**

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Jarred Walton

TECH TALK

How Many Cores and Threads Do We Need?

OK, AMD, YOU WIN: All the cores and threads belong to you. What started with Ryzen several years ago has culminated in a monstrous 64-core/128-thread chip, double what was available in the previous second-gen Threadripper parts. They easily eclipse anything Intel has to offer.

There's only one small problem: Most of us really don't need this many cores or threads.

Threadripper 3990X is a chip built with specific workloads in mind, and if you're not using one of those workloads, performance can actually be worse than its "little brother" 3970X, which has half as many cores and threads. I'm not talking about the slightly lower clock speeds either.

The 3990X takes AMD's currently largest Epyc design, disables half of the eight memory channels, then wraps up it in a "consumer" package. Except, with a price of $3,990, plus the need for more RAM and a very high-end motherboard, this takes the HEDT (high-end desktop) market to new extremes. It's not for home users, or even enthusiasts—it's built for professionals. More specifically, it's built for professionals who do a lot of 3D rendering.

You might think just about any multithreaded workload would run better on the 3990X than the 3970X—twice as many cores can't be bad, right? However, due to the way Windows 10 was built, you end up with two groupings of 64 threads in Task Manager, and scheduling of workloads across those groupings doesn't always work as expected.

Video encoding doesn't really know what to do with the 3990X. HandBrake is barely any faster with x264 encoding, and is slightly slower in x265 mode. Adobe Photoshop and Premiere Pro are both faster on a 3970X. There are numerous lighter applications where the 64-core behemoth falls well behind other CPUs—including tasks such as gaming, general Internet use, and office work.

But then you get to 3D rendering and fire up Blender with a complex scene, and suddenly all those cores are put to good use. Blender, Cinebench R20, V-Ray, POV-Ray, and Corona all have the 3990X beating the 3970X by 45-65 percent. Not surprisingly, AMD's marketing behind the Threadripper 3990X was heavy on the Hollywood-style 3D rendering.

The 3990X has eight CPU chiplets and an IO die beneath its heat spreader.

Now that 64-core CPUs are becoming more affordable, we should see app—and Windows—support for such chips improve as well. But there's another problem with higher core counts: software licensing fees. Windows has already moved away from a per-socket fee to a per-core fee. VMware recently announced two tiers of pricing as well: one for up to 32 cores, and you'd buy a second license for each additional 32 cores. Oracle has been charging per core for a long time, too.

I'm not saying we'll never need a 64-core CPU in our home PCs, but it could be decades before such systems become common. Or maybe they never will, considering the rise in smartphone use for media consumption, email, and more. Still, something has to do the heavy lifting for Hollywood, not to mention the servers behind all the smartphone networks....

Even so, I wonder what AMD has planned. Zen gave us 16-core Threadripper 1950X, Zen+ delivered 32-core Threadripper 2990WX, and now Zen 2 drops a 64-core bombshell on the 3D rendering community. Will we see 128-core or even 256-core chips? Possibly, though doubling down yet again might not deliver the hoped for performance. We are well past the point of diminishing returns.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

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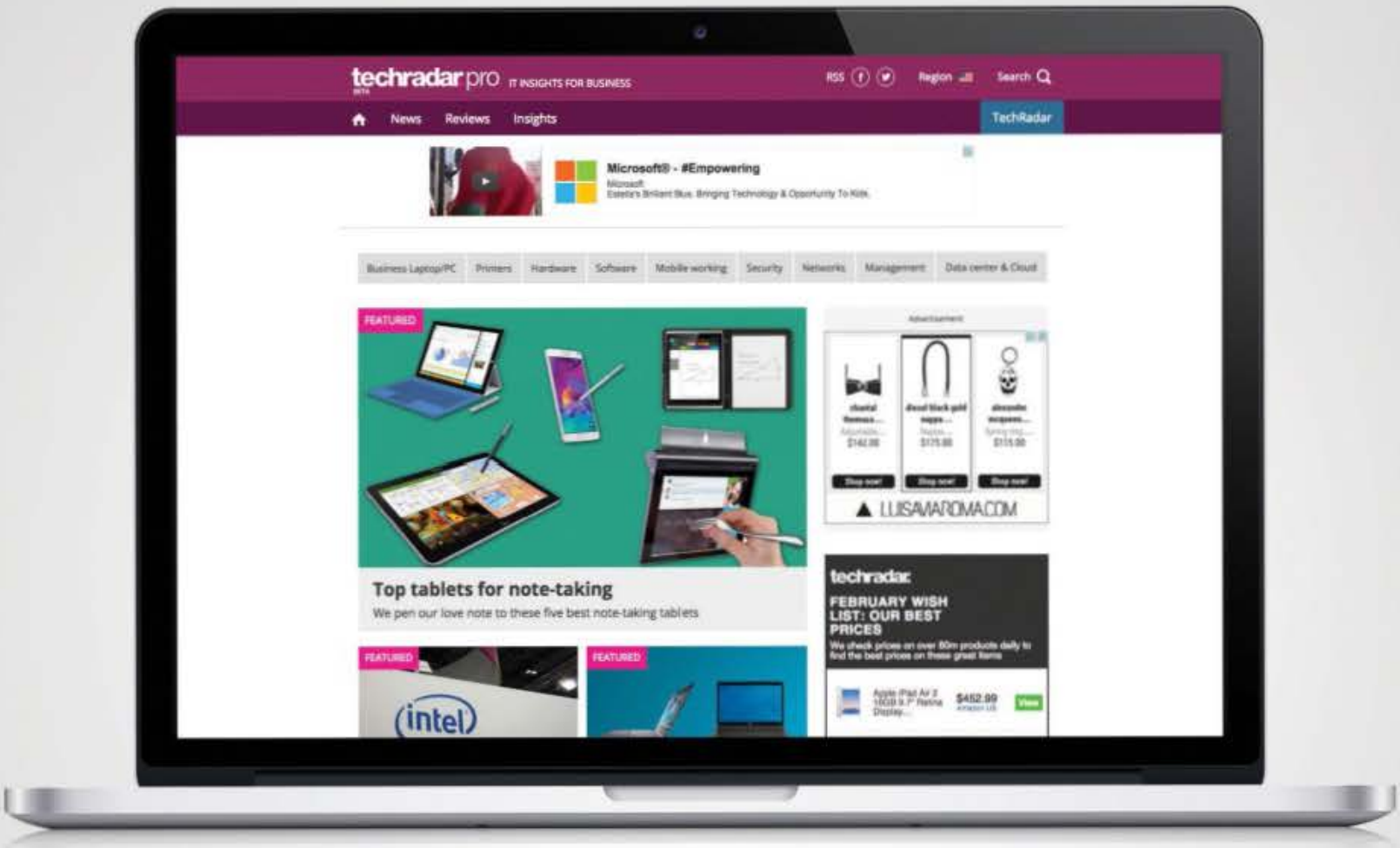

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Alex Campbell

OPEN SOURCE

Are Docker Containers a Good Idea for Laptops?

DOCKER CONTAINERS are great for a ton of reasons. They allow for temporary or permanent environments for applications to run in pseudo-isolation from the host system. But don't get it twisted: Running an app in a Docker container isn't necessarily safer than running it on the host OS.

Docker containers are cool. If you haven't yet played with Docker, you're missing a large world of easily deployed applications. For example, I can deploy NodeRed, Plex, Jupyter Lab, and Nextcloud servers, and run them behind a Traefik reverse proxy with a single command and a YAML text file. If you're running an HTPC, NAS, or home Linux server, Docker lets you do just about anything.

Containers (like Docker containers) emulate a filesystem, networking, and other OS components in order to allow applications to isolate themselves from the host OS. Containers generally don't require dedicated resources, so they're often preferred to virtual machines for single applications.

Installing web apps such as Plex or Nextcloud directly on to your OS can be a pain, depending on the application stack. Windows-esque "DLL Hell" has its evil brother on Linux in the form of broken dependencies. If one program requires a different version of a library from another program, updating or installing those two programs together can be tricky, if not impossible. Containers fix this by packing up all the dependencies for a container's image (like a package) and running them in an isolated environment. If a web app requires a particular version of Python, using a Docker container prevents it from conflicting with the OS's version. Flatpak and Snap packages are containers in many ways, but the formats are largely geared toward desktop use. The Docker image paradigm is king when it comes to web and applications.

> "Podman aims to be close to a drop-in replacement for common Docker tasks.

There is one glaring problem. The Docker daemon must run as root. So, anyone who can talk to Docker has root privileges. As a result, any container running on the system can potentially obtain root privileges on the host. The other problem is that Docker's networking stack can play hell with the Uncomplicated Firewall (ufw), a common default firewall for many Linux distros. Because the Docker daemon has root access, IPTables can happily overwrite ufw's rules without letting you know.

There is a better way if you're not looking to deploy a web service on a network. Podman aims to be close to a drop-in replacement for common Docker tasks. It can grab Docker images from online repos and deploy them with the same commands you'd use with Docker (but using "podman" instead of "docker"). Its sister app Buildah builds container images from Docker files, too.

Podman doesn't run as a daemon, so doesn't require root. This also means that containers started by non-root users can't get root privileges either. However, without the Docker daemon, there's no process to watch after Podman containers. This requires the user to run some other service (such as Systemd) to start and stop container instances. Podman refers to "pods" in the Kubernetes ("k8s") sense. A Kubernetes pod is made of one or more containers that are created and destroyed as one. (A "node" is a single virtual machine that hosts pods.) Podman is an alternative interface for launching pods on a Kubernetes cluster. The Kubernetes supervisor orchestrates node and pod deployment, so the Docker daemon isn't necessarily needed.

Podman runs lighter (and safer) containers for everyday use.

Feeling adventurous? Try the k3s project, which removes some overhead from Kubernetes. K3s is designed to run on embedded systems, but is a great way to learn Kubernetes on a local system, with no hefty setup or VM overhead.

Alex Campbell is a Linux geek who enjoys learning about computer security.

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THE LIST

BEST CONTROLLERS FOR PC GAMING

8 STEAM CONTROLLER

Valve's effort at a PC controller is far from perfect; it was designed to play games that weren't made with controller support in mind. For that, it works great. **$70**

4 MSI FORCE GC20

A simple and cheap wired controller that doesn't sacrifice design quality, despite its low price. The analog sticks in particular have a pleasing amount of resistance. **$29**

7 LOGITECH F310

An affordable, reliable option from peripheral master Logitech. It isn't wireless, but the build quality is solid without being too heavy, and it's easy to plug and play. **$25**

3 ASTRO C40 TR

Originally designed as an upmarket Dualshock alternative, the Astro C40 TR is an incredibly high-quality moddable controller. It's certainly on the pricey side, though. **$200**

6 XBOX WIRELESS CONTROLLER

Since the release of the Xbox One's Elite controllers, the standard wireless models have become even cheaper, and they work great with PCs, too, thanks to Bluetooth connectivity. **$50**

2 XBOX ELITE WIRELESS CONTROLLER SERIES 2

A luxury upgrade to the already excellent Xbox Elite, the Series 2 model comes with incredible customization and a new carry case with built-in charging capabilities. **$180**

5 XBOX ELITE WIRELESS CONTROLLER

If you've got a larger budget, Microsoft's Elite controller is a weighty affair with excellent companion software and reconfigurable design that lets you switch out parts easily. **$150**

1 RAZER WOLVERINE ULTIMATE

While it has to be connected via cable to PCs, Razer's Wolverine Ultimate gamepad is a robust unit with fantastic physical response on every button and full Chroma lighting support. **$160**

© VALVE, LOGITECH, MICROSOFT, MSI, ASTRO GAMING, RAZER

HEAD TO

BY **CHRISTAIN GUYTON**

Google Stadia vs. Nvidia GeForce Now

The launch of Stadia, Google's push into the game-streaming arena, was troubled at best, and user numbers are already struggling, while other platforms have drawn comparisons with Google's offering. So, we're working out which one is best; Stadia's primary competition here is Nvidia's GeForce Now, originally designed for its Shield TV, but since expanded for PCs and mobile devices. Which is the superior service? Let's take a look.

ROUND 1

Value

Stadia and GeForce Now are both subscription services, though the price points vary, and there are different hardware options. Stadia requires a specific controller and Chromecast Ultra, which can be purchased in a bundle for $129. GeForce Now requires a PC, Mac, or Android device. Naturally, both require a TV or monitor, and a high-speed Internet connection.

Both Stadia and Now offer free and paid subscription services, but at the time of writing, Google's free service isn't available yet. Looking at the paid options puts Nvidia ahead. GeForce Now's premium membership costs $5 a month, half that of Stadia Pro, and offers ray-traced content. However, the premium Stadia subscription offers more: 5.1 surround sound, regular free games, and exclusive discounts on Stadia store games.

GeForce Now also has limited playtime. The free model only allows one-hour sessions, although the paid subscription allows six-hour sessions. It isn't a content platform either, as Stadia is; you need your own games. Ultimately, GeForce Now is better value, thanks to compatibility with platforms such as Steam and Uplay.

Winner:
GeForce Now

ROUND 2

Performance

Stadia had a big leg up on GeForce Now thanks to the 4K resolution offered by the Pro subscription. Google has also improved Stadia's performance since its November release, while GeForce Now has stuck to 1080p for the entire duration of its five-year beta. Fully released in February, Now has seen a positive response thanks to reliable performance at 720p and 1080p, even on slower Internet connections (nothing lower than 15MB/s, though).

Both run well with high-speed fiber optic. Both have 60fps options, and latency is almost non-existent if your connection is fast enough. Single-player titles almost unilaterally run smoother than games with online multiplayer. Stadia nabs another point thanks to its Wi-Fi-enabled controller, which cuts down latency a little more.

RTX functionality would be a big plus for GeForce Now, if it weren't for the fact that the number of games that support ray-tracing can be counted on your fingers. Once (if) ray-tracing reaches better industry penetration, GeForce Now might begin to look like the superior option. While it's a nice addition, it isn't enough to trump 4K streaming, so the win goes to Google.

Winner:
Stadia

ROUND 3

Game Selection

For all its innovation, Stadia is not unlike a home console, with its own Google-mediated library of games available for digital purchase. GeForce Now connects to any major storefront, and allows you to play games you already own. Stadia Pro subscriptions come with a couple of free games every month, but the selection is limited, and the free games have failed to impress.

While GeForce Now's premium subscription doesn't provide any games, the ability to access numerous digital storefronts means that the game selection is almost infinitely wider. If you're already a PC gamer, you can bring most of your games—ideal if you want to play the latest games but lack the hardware needed.

Steam alone would be enough to smash any other platform's lineup, but Stadia's puny game library barely requires a tap to topple. Around 30 games isn't enough to carry a platform, especially when that selection is almost exclusively high-priced triple-A games. Stadia doesn't feel friendly to indie developers—one of the great benefits of the PC gaming industry as a whole. It just can't win against the existing juggernaut storefronts on PC.

Winner:
GeForce Now

HEAD

While both platforms are practically hardware-free, Stadia does require use of Google's nifty Wi-Fi-connected controller.

Nvidia's Shield streaming device is just one way to play using GeForce Now; desktops, laptops, and Android mobile devices are all fair game, too.

ROUND 4

Ease of Use

Stadia is inherently easy to use. Once the controller is connected to your Wi-Fi network, getting your games up and running is a cinch. Whether it's selecting Stadia from your Chromecast on a TV or using the mobile app, getting to your games is a smooth process. You can even stream your games via Chrome on a PC or Mac.

GeForce Now needs the installation of a specific client from Nvidia, and the registering of digital storefront accounts. It's a longer setup period, and buying games still requires the use of existing third-party storefronts. While Stadia has a far shorter list of games available, buying and playing a game is a streamlined process.

Stadia's UI is also better than GeForce Now. Navigating Stadia is a smooth, satisfying experience, familiar in aesthetics and functionality to anyone who uses Google's other services. The all-white background is a bit bright, but we have no other criticisms. GeForce Now's UI is messier. If a game is available via multiple third-party launchers, the search function can be wonky, sometimes locating the wrong version of a game. Stadia's simplicity creates a more enjoyable experience.

Winner: Stadia

ROUND 5

Design

Google's genius with the Stadia is the controller. The physical design is top-notch—comfortable in the hands and taking the best elements of the Xbox and PlayStation controllers. But this goes one step further, thanks to direct Wi-Fi connectivity. While the primary source of latency in game-streaming platforms will likely always be the physical distance between your router and the hosting server, controller-to-console latency can be an issue.

Connecting directly to Wi-Fi eliminates latency not just from the controller to the system, but also from the system to the local Wi-Fi network. It's a masterstroke. The Chromecast Ultra is also a well-made piece of gear, easily one of the best content-streaming solutions on the market—although, technically, it's only required to play Stadia games on your TV.

GeForce Now requires no specific hardware from Nvidia, although there is the Shield. Essentially a streaming device not unlike a Chromecast, the Shield is a sleek unit, with a great remote, easily beating most streaming solutions. It's awesome, but as it's not part of the necessary GeForce Now setup, the win has to go to Stadia.

Winner: Stadia

And the Winner Is...

We were surprised to reach this conclusion, but we have to admit it: Google Stadia is pretty much the best game-streaming service available right now. If you're not the sort to shell out two grand for a gaming PC, but still want to play the latest big titles, it's got you covered, with an easy-to-use interface and familiar controller. Yes, it's not the best value in the long term, and the game selection on offer is limited, but Stadia is a well-polished and smartly designed service.

GeForce Now offers a platform that likely appeals more to committed PC gamers who simply lack the hardware, or want to play their games on mobile devices. Stadia is flashy, but if you already own a sizable Steam library, it probably won't appeal. The ability to play your own games at max settings thanks to GeForce Now is a boon to cash-strapped PC gamers.

Ultimately, both services have their benefits, but Stadia is more refined. GeForce Now has been through a few iterations, originally packing its own game library for subscribers, like Stadia, so perhaps Nvidia just hasn't quite found the magic formula yet.

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DOCTOR

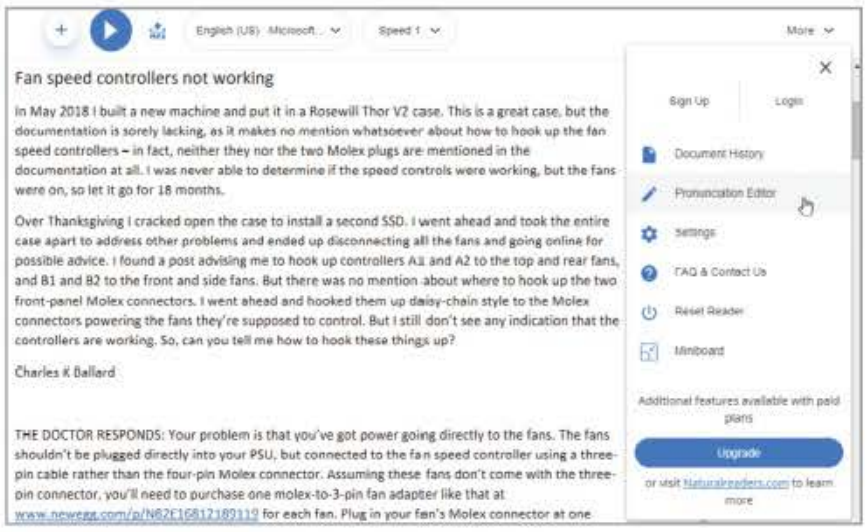
THIS MONTH THE DOCTOR TACKLES...

> Video-Editing Gear
> DisplayPort Woes
> DIY Audiobooks

Upgrade Advice

I have a Gigabyte GA-H67A-UD3H-B3 motherboard with an Intel Core i7 Sandy Bridge (2700K I think), Zotac GT610 graphics with 2GB of 64-bit DDR3, and a 500W supply. I would like to upgrade the motherboard and CPU—everything else is fine. How do I change the motherboard and get it to boot from the existing 1TB SSD? I mostly do audio and video editing. Any suggestions on motherboard and CPU?

–Mike Rockwell


Fan speed controllers not working
In May 2018 I built a new machine and put it in a Rosewill Thor V2 case. This is a great case, but the documentation is sorely lacking, as it makes no mention whatsoever about how to hook up the fan speed controllers – in fact, neither they nor the two Molex plugs are mentioned in the documentation at all. I was never able to determine if the speed controls were working, but the fans were on, so let it go for 18 months.
Over Thanksgiving I cracked open the case to install a second SSD. I went ahead and took the entire case apart to address other problems and ended up disconnecting all the fans and going online for possible advice. I found a post advising me to hook up controllers A1 and A2 to the top and rear fans, and B1 and B2 to the front and side fans. But there was no mention about where to hook up the two front-panel Molex connectors. I went ahead and hooked them up daisy-chain style to the Molex connectors powering the fans they're supposed to control. But I still don't see any indication that the controllers are working. So, can you tell me how to hook these things up?
Charles K Ballard
THE DOCTOR RESPONDS: Your problem is that you've got power going directly to the fans. The fans shouldn't be plugged directly into your PSU, but connected to the fan speed controller using a three-pin cable rather than the four-pin Molex connector. Assuming these fans don't come with the three-pin connector, you'll need to purchase one molex-to-3-pin fan adapter like that at
www.newegg.com/p/N82E16812189119 for each fan. Plug in your fan's Molex connector at one
Sign Up
Login
Document History
Pronunciation Editor
Settings
FAQ & Contact Us
Reset Reader
Miniboard
Additional features available with paid plans
Upgrade
or visit Naturalreaders.com to learn more

Convert text documents to MP3 audio files with NaturalReader.

THE DOCTOR RESPONDS:

Things are a little more complicated when it comes to swapping out motherboards. You're effectively building a new PC, albeit cannibalizing large parts of your old one in the process. Windows 10 can survive major hardware changes like this—the Doc has seen first-hand how a new AMD X470 PC was able to boot an old Ivy Bridge Windows install, settling down after a few reboots, driver updates, and blue screens of death, with apparently no lingering ill effects.

Nevertheless, your best bet is to back everything up and perform a fresh install of Windows on the "new" machine. But before doing so, verify your current license can be migrated to your new mobo—it needs to be on the RETAIL rather than OEM channel. To do this, open Command Prompt as an administrator, then type the following and hit Enter:

```
$ slmgr /dli
```

If it's OEM, you need to source a new copy of Windows. A few other considerations, too: A new motherboard means new RAM as well as the CPU. The more you can afford, the better—8GB is considered entry level these days, so look for 16GB or even 32GB if you can afford it. Your Zotac graphics card isn't important for video editing, but if you want the option of connecting a 4K monitor now or in the future, you should consider upgrading—pick a CPU with onboard graphics in this case.

Most recommended video-editing builds are Ryzen-based because you get more cores for your money, which is critical for video editing. If you're happy editing HD video only, a Ryzen 5 1600 CPU (six cores, 12 threads) is sufficient; pick the Ryzen 5 2400G for its onboard graphics if the 4K monitor appeals.

For 4K video editing, the Ryzen 7's eight cores and 16 threads are recommended, but with no onboard graphic options available, you'll be stuck with HD displays for now. The Ryzen 7 2700 is a good budget choice, but for those looking to go beyond 4K, the Ryzen 7 3700X is the chip to choose.

In terms of motherboards, check our reviews pages for the latest recommendations. The B450 chipset is fine for HD-editing builds, but aim for the X470 or even X570 chipset for higher resolutions.

DisplayPort Issues

Hey Doc, I have a two-year-old system as follows: Asus Maximus VIII Ranger motherboard, Core i7-6700K CPU, 16GB RAM, MSI GTX 1080 Armor GPU, and recent Western Digital Blue 3D NAND M.2 SSD upgrade. Since I added the new M.2 SSD, the DisplayPort connectors on my video card stopped working and I can only use HDMI. I understand they use same PCI bus but what gives? Any help would be appreciated. Thanks.

–Jim Cafiero

THE DOCTOR RESPONDS:

DisplayPort issues are quite widespread—it's certainly less reliable than the good ol' HDMI connection, which seems to be the default fallback in cases like these.

There's no specific mention of the M.2 slot being in conflict

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↘ submit your questions to: doctor@maximumpc.com

or sharing resources with the PCIe slots in your mobo manual—SATA ports 1 and 2 are disabled when it's in use, but it should have no effect on the DisplayPort adapter. The Doc is well aware of issues with DisplayPort connectors displaying blank screens on DisplayPort 1.3/1.4 displays on Quadro, 700, 900, 10, and Titan series cards; Nvidia released an update (www.nvidia.com/en-us/drivers/nv-uefi-update-x64/) back in 2018. But you'd need to first verify your monitor has a DisplayPort 1.3/1.4 connection, rather than the older 1.2 connection.

You should also check your motherboard BIOS is fully up to date—Asus has released quite a few BIOS updates since its initial release, some of which refer to issues with M.2 and SSD devices, and although the WD Blue isn't mentioned by name, you may find one of these magically resolves the problem.

If neither works, you might want to try several workarounds: unplugging and replugging in the DisplayPort cable (not a long-term fix), or even trying a different cable. Another workaround involves HotKey Resolution Changer (see the Nvidia forum at http://bit.ly/2UL16nv for details). You'll see from the comments that the problem is not new, and continues to plague users to this day.

Making Audioboooks

I read with interest your audiobooks feature in the Holiday 2019 issue. However, there's one aspect that wasn't covered: Do you know of any software capable of transforming RTF or DOC files into audio files and combining them into an audiobook? Creating an audiobook by having someone read the text into a mic is long, fastidious, and likely expensive. It would be very useful to be able to create clear and usable audio files, and audio books, with some version of a speech emulator. I ask because I publish ebooks and it would be worthwhile to create audio versions of these. Amitiés.

–Pierre Corbeil

THE DOCTOR RESPONDS: The text-to-speech market has developed remarkably over the past few years—you no longer have to put up with the stilted delivery of the voices found in Windows (search the Microsoft Store for the free ad-supported Audio Book Maker from Z Mobile Apps to try creating an audiobook using these voices). That said, while professional services mean you can—for a cost—enjoy more natural-sounding voices in a range of accents and languages, the tell-tale sound of a computer remains even with the best of them. Nevertheless, it's still cheaper than hiring a voice actor.

A good example of how this works is NaturalReader (www.naturalreaders.com). The personal version can be bought for a one-off fee, with a range of additional different voices and accents, including French, US English, and British English, available as add-ons ($32.50 each). Sadly, the license for these (including the Professional version) prohibits public distribution of your audiobooks, whether for commercial or non-commercial purposes. Nevertheless, you should start here with the free version to see what can be done and what kind of results you might expect.

When it comes to generating audiobooks to share with others, you'll need to pay for the monthly Commercial subscription (www.naturalreaders.com/commercial.html). In your case, the Doc believes a monthly license ($99 per month) is probably the best approach—you get access to 61 different voices across all available languages, and can convert one million characters to speech per day, which should be sufficient to get several projects done in the space of each month.

Laptop Boot Problems

I have an old HP Laptop (Pavilion 6700) on which I installed Windows 10 during the free upgrade period. After installing recent updates, however, it will no longer reboot. If I leave it for around 10 minutes, then it'll boot normally, but when rebooting, it doesn't POST. Power comes on, it tries to access the CD drive, and switches itself off, repeating the process until I cut power.

I've managed to run diagnostics on the memory and hard drive with no problems. I've repaired and reinstalled Windows, plus tried to install Chrome OS, also with no solution, so I'm not sure it's an OS problem at this point. I've looked through the BIOS, removed the CD drive from the boot options, but still the same problem. Any suggestions as to what the problem might be?

–Phil Nicholls

THE DOC RESPONDS: You're right to blame your hardware—the problem seems to be related to one that has plagued DV6700 owners since the laptop's early days in the late noughties. All pointers suggest a problem with the mobo or onboard components, possibly through chip creep or the development of bad solder joints (see http://bit.ly/39qzesT for a lengthy online discussion going back to 2010).

If you feel brave enough, try stripping back to the motherboard to see if the CPU has become misaligned or whether you can see problems with soldered joints. You might even be tempted to dabble in some questionable techniques, such as baking the motherboard in an oven to try to reflow the solder back into place—check out www.computerrepairtips.net/how-to-reflow-a-laptop-motherboard/—but note the repair would be temporary at best and the effort involved seems OTT for such an old machine. Perhaps now is the time to retire it—boot into it one last time to take a fail-safe drive image, then repurpose the drive elsewhere.

Folder Sort Options

Can you help me save a few thousand clicks of my mouse by adding "Date modified" to the option for sorting files in individual folders? I'm using Windows 10 and, by default, the choices are limited to "Name," "Date," "Type," "Size," and "Length." I can—of course—choose "More..." from the "Sort by" menu to bring up "Date modified," but then I must go through the process every time for new folders. As I'm always manipulating photos and need to keep them ordered by date modified, it's a really frustrating process.

Can I tweak a setting to make "Date modified" appear by default?

–Jay Cole

THE DOCTOR RESPONDS: Simple answer is yes. It's convoluted, but possible—the "Sort by" setting can be saved as part of a folder template. Navigate to your main "Pictures" folder, right-click, and choose "Customize this folder." Verify that "Pictures" is selected under "What kind of folder do you want?" and that "Also apply this template to all subfolders" is checked. Click "OK."

While you're at it, you can sort the folder by "Date modified," too. Right-click inside the folder again and verify "Date modified" is available as a default selection under "Sort by." The next step applies both preferences to all "Picture"-based folders, so you won't even need to click once in future: Switch to the File Explorer ribbon's "View" tab and click "Options → Change folder and search options." Select the "View" tab and click "Apply to Folders" followed by "OK." You should now find all your picture folders have been updated to include the same settings.

SPEED UP WINDOWS

ALL THE BEST TIPS, TRICKS, AND DARK INCANTATIONS TO MAKE YOUR OPERATING SYSTEM RUN FASTER

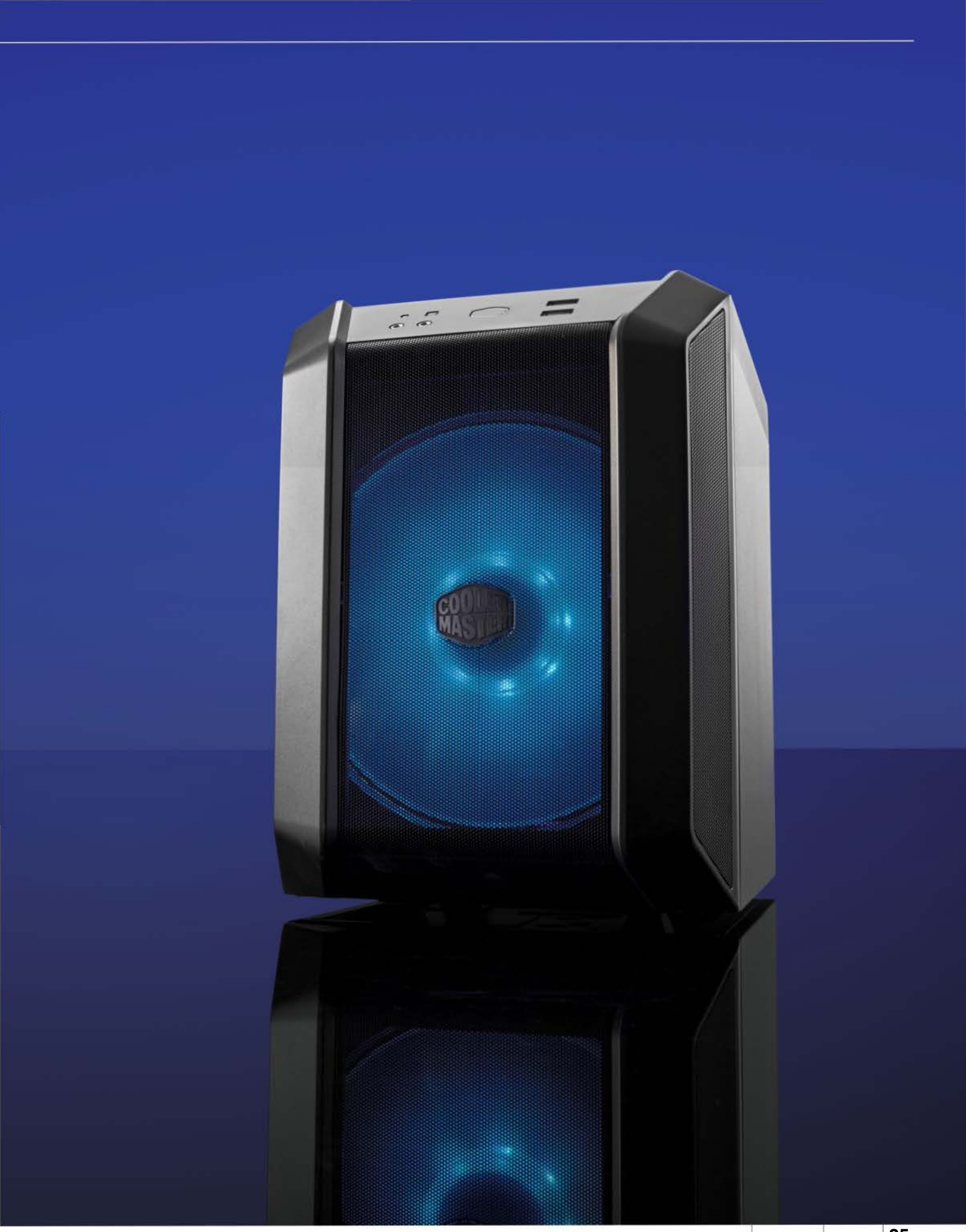
WITHSUPPORTFORWINDOWS7GONE and Windows 8 bearing an ominous expiration date (albeit one that is three years from now), there's never been a better time to make the jump to Windows 10. For our money, it's the best operating system since the Old Faithful that was XP Professional. Actually, if you haven't upgraded already, what's holding you back? The 10th iteration of Microsoft's flagship OS has been around for almost five years now.

If you're already a card-carrying member of the Windows 10 club, though, you probably want to squeeze the absolute best out of your OS, whether you're using your computer for gaming, work, or just a spot of Netflix and chill. There's plenty of ways to do this, mostly using tools that are built into Windows 10; a huge selection of nifty functions, apps, and settings to be tweaked to make for the ultimate experience. It's not just ease-of-use stuff, either; if you're a hardware head, Win 10 is a powerful tool for system optimization and monitoring. Lots of things that might demand third-party software elsewhere can be done directly in the OS, be that disk defragmenting, malware eradication, or something else entirely.

Yes, it lacks the raw flexibility of Ubuntu or the super-sleek interfaces of macOS Catalina, but the fact remains that Windows 10 is the most popular OS for home computers right now. We don't think it's a stretch to claim that everyone reading this has used Windows at some point. If you haven't, write to us with your life experiences, because they sound interesting. Windows has permeated almost every aspect of computing over the years, and in 2020, it's no different.

Of course, it's not perfect, but there's customization aplenty; even the bad elements of Win 10 can be adjusted, mitigated, or disabled entirely. Annoyed that Cortana won't leave you alone? Frustrated with your CPU always running hot due to background programs? Don't worry, we're here to help. Over the next few pages, we break down all the best tips for creating your ideal OS experience, whatever you use your system for.

CHRISTIAN GUYTON



GENERAL TIPS FOR WINDOWS 10

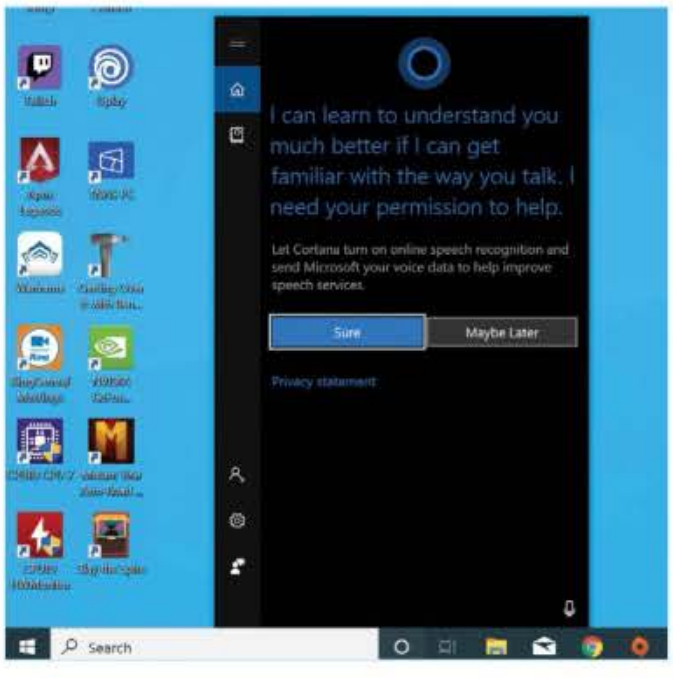
Keeping Windows up to date can feel like a rather Sisyphean task at times.

01 KEEP WINDOWS FULLY UP TO DATE

Ah, the Windows Update. Truly the modern-day raven, rap-tap-tapping on Edgar Allen Poe's operating system with menacing intent. Taking control of your updates is objective number one for anyone trying to optimize their PC, so jump into "Update Settings" and remember to smash that "Check For Updates" button. You can turn on auto-updates, too, under "Advanced options," but if you have a metered connection, we advise against this, and instead recommend manual updates. You can also pause all updates for up to two weeks; useful if you want to try something in a specific version of Windows 10.

02 SHUT CORTANA UP

Get her out! For the vast majority of users, Cortana is little more than a frustration baked into the core of Windows 10. Annoying pop-ups, constant data-gathering, and forced Bing search (come on, Microsoft...) make Cortana the least helpful voice assistant in the biz, but fortunately, shutting her down is reasonably straightforward. Find the Cortana page under "Settings," then toggle all the sliders off. To complete the process, head back out to the main "Settings" menu. Under "Privacy Settings," you'll find "Speech" and "Inking and typing personalization." Turn both of these off to cut down the amount of data Cortana gathers from your typical PC usage. You can also block all apps from accessing your camera and microphone on the "Privacy" page.


I can learn to understand you much better if I can get familiar with the way you talk. I need your permission to help.
Let Cortana turn on online speech recognition and send Microsoft your voice data to help improve speech services.
Sure
Maybe Later
Privacy statement
Search

We're sure a select few of our readers find Cortana helpful. We do not.

03 DISABLE STARTUP APPS

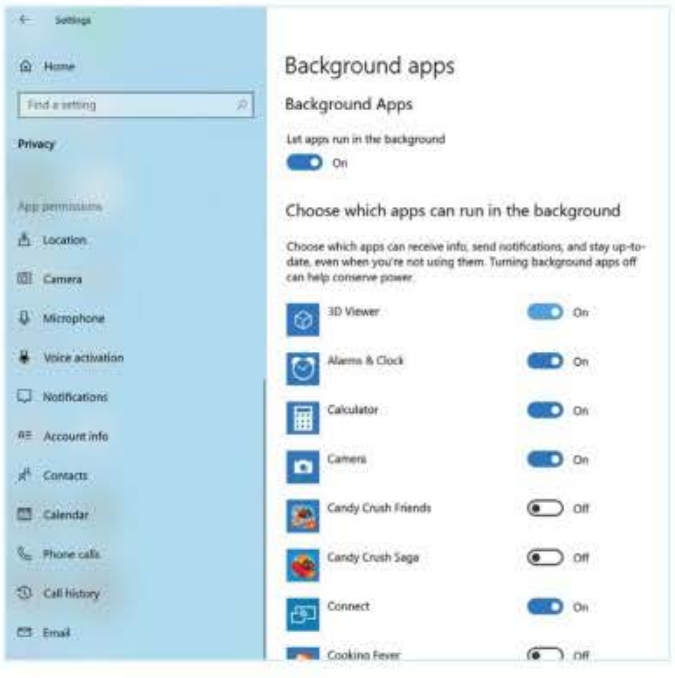
We've all been there, booting up our PC to get a quick task completed, only to be waylaid by Spotify, Steam, Uplay, and Discord introducing themselves like the worst barbershop quartet of all time. Windows has you covered, though—the "Startup" page under "App Settings" lets you view which apps are set to start up immediately (albeit in the background) when you log into Windows, and also which ones have a higher impact on your boot times. Toggle off any of these that you want to open manually, such as Spotify or OneDrive, and your system should start up faster.

04 DISABLE BACKGROUND APPS

This one comes down to preference, and isn't so necessary on more powerful systems with plenty of memory and high-speed storage. Under "Privacy Settings," you can individually select which apps you want to run in the background, and disable the rest. There's a ton of tools included with Windows 10 that you might use sometimes, but don't ever want running in the background. Windows News? Disabled. Voice Recorder? Deactivated. Xbox Console Companion? Begone!

05 UNINSTALL UNWANTED APPLICATIONS

Speaking of stuff included with Windows 10, there's plenty of bloatware you can just get rid of. The most obvious contender is of course *Candy Crush*, but if you take a trip into "App Settings" and scroll through the "Apps & features" list, you may find a surprising amount of software you never use, and



Keep your background apps to the bare minimum whenever possible.

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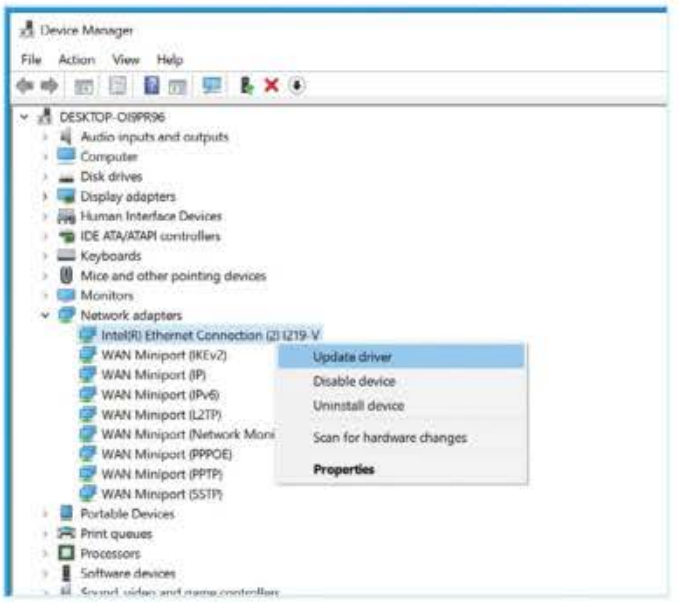


If something isn't working, check all of your drivers are up to date in the Device Manager.

never intend to use. Click on a program to view options, and uninstall it from there. If you're unsure what a piece of software does, always look it up online before removing it.

06

UPDATE DEVICE DRIVERS

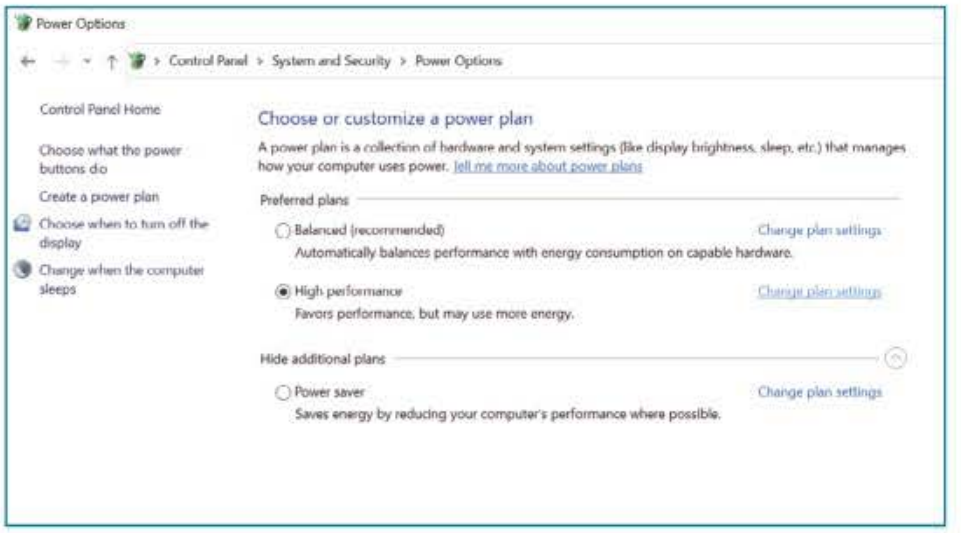
Updating your drivers is often a handy fix for something not working with a PC, but it's a good idea to keep your device drivers up to date whenever possible. To check for updates, right-click the "Home" button and select "Device Manager," then right-click the device you want to update the drivers on. You can also scan for new hardware here; if you change something about your physical setup, you might need to relocate it within the Device Manager in order to update the drivers and ensure everything is working properly.

07

LOG IN FASTER

The Windows 10 lock screen is a pointless innovation. Having to swipe up or hit the spacebar before logging in slows things down a bit, and using a conventional password is slower, too. First up, assign a PIN rather than a password for logging in; four digits and no need to hit Enter, either. If your system supports it, Windows Hello is pretty speedy, too. You can even remove the lock screen altogether, going straight to the login screen upon boot. Annoyingly, how you do this is different for Windows 10 Home and Windows 10 Pro. For Windows 10 Home edition, you need to run regedit from the "Run" prompt, make your way to "HKEY_LOCAL_MACHINE → SOFTWARE → Policies → Microsoft" and right-click "Windows," select "New → Key" and call it "Personalization." Once created, right-click this key and add a new "DWORD (32-bit) Value," with a name of "NoLockScreen." Double click this and set the "Value" to 1. For Win 10 Pro, hit Win-R, type "gpedit" and hit Enter. Double-click "Administrative Templates," double-click "Control Panel," click "Personalization," then double-click "Do not display the lock screen," and click "Enabled." Click "Apply," and then "OK." Job done.

LAPTOP TIPS


Power Options
Control Panel > System and Security > Power Options
Control Panel Home
Choose what the power buttons do
Create a power plan
Choose when to turn off the display
Change when the computer sleeps
Choose or customize a power plan
A power plan is a collection of hardware and system settings (like display brightness, sleep, etc.) that manages how your computer uses power. Tell me more about power plans
Preferred plans
Balanced (recommended)
Change plan settings
Automatically balances performance with energy consumption on capable hardware.
High performance
Change plan settings
Favors performance, but may use more energy.
Hide additional plans
Power saver
Change plan settings
Saves energy by reducing your computer's performance where possible.

Switching to Power Saver plan can be useful for prolonging battery life.

08

Check Your Power Plan

It's worth taking a peek at your power plans in the Control Panel on a laptop, found under "Hardware and Sound." If it's a powerhouse laptop that you're essentially using plugged-in as a desktop replacement, slap that high performance plan on and call it a day; otherwise, you'll want to take a trip into the advanced power plan settings. The default balanced plan is usually a good call, but even then you might want to make some adjustments; like disabling certain ports while the monitor is asleep, for example.

09

Disable Tips

Windows 10 wants to be helpful, but like a bumbling manservant, sometimes that help is actually less than helpful. By default, Windows 10 scans your system periodically to give you (usually unwanted) advice, and this can have a small impact on mobile processor performance, particularly in cheaper laptops. You can turn it off in System Settings, under "Notifications and action." Just toggle off the slider marked "Get tips, tricks, and suggestions as you use Windows."

10

Manage Your Temperatures Better

As we said earlier, it's a good idea to use third-party software, such as HardwareMonitor, to keep an eye on your system temperatures. This is even more critical with laptops, where keeping your CPU cool is an even more difficult endeavor. If you're regularly using demanding software on your laptop—3D rendering tools, for example—then heat spikes are inevitable, but there are a few things you can do to alleviate the temperature load on your poor laptop. The general optimization tips elsewhere in this article are a good start, but making sure you're positioning your laptop right is important, too. Don't actually put it on your lap, for starters. Ensure that all the air vents are clear, and only use it on hard, flat surfaces. If you have problems with temperature, consider using something to prop your laptop up, creating more empty space beneath it for better airflow.

11

CREATE A RESTORE POINT AND RESTORE YOUR SYSTEM

If all hope is lost, returning to an earlier save point is the best course of action. This advice holds true for both videogames and Windows 10, although hopefully you'll never have to use it. In the Control Panel, go through "Security and System → System → System Protection," and you'll open up the

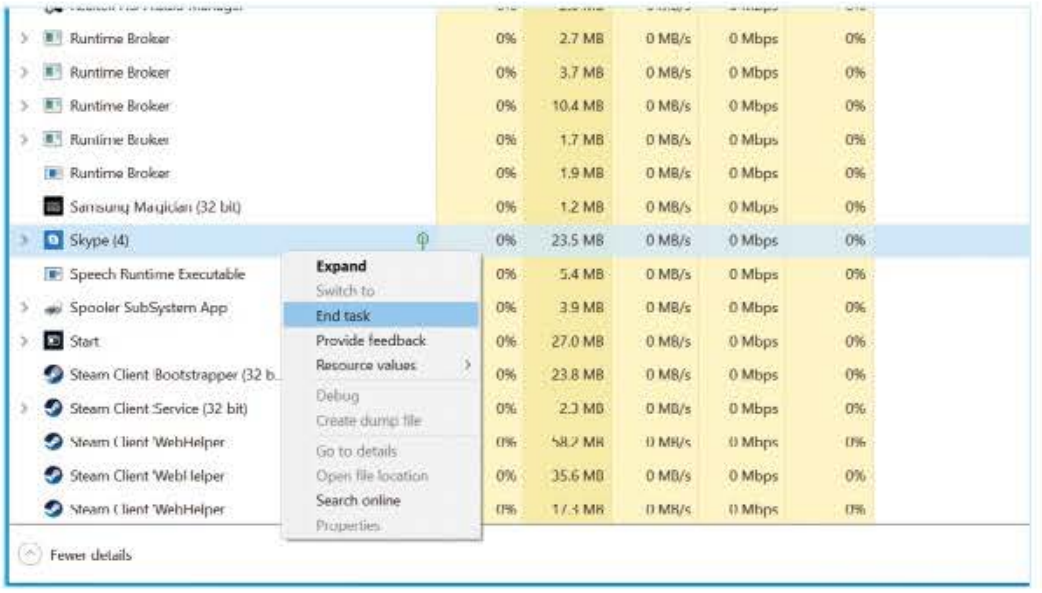
window for system restore options. You can hit the big "System Restore" button to revert your version of Windows to a saved restore point; your PC should regularly create these by default, but it saves over the previous one when it does so. Hit "Configure" and you can tweak your restore settings, or create new restore points. This isn't something you need to do too often, but it's worth having restore points for each of your drives, just in case a new software or OS update causes problems.

12 TRACK CPU USAGE AT ALL TIMES

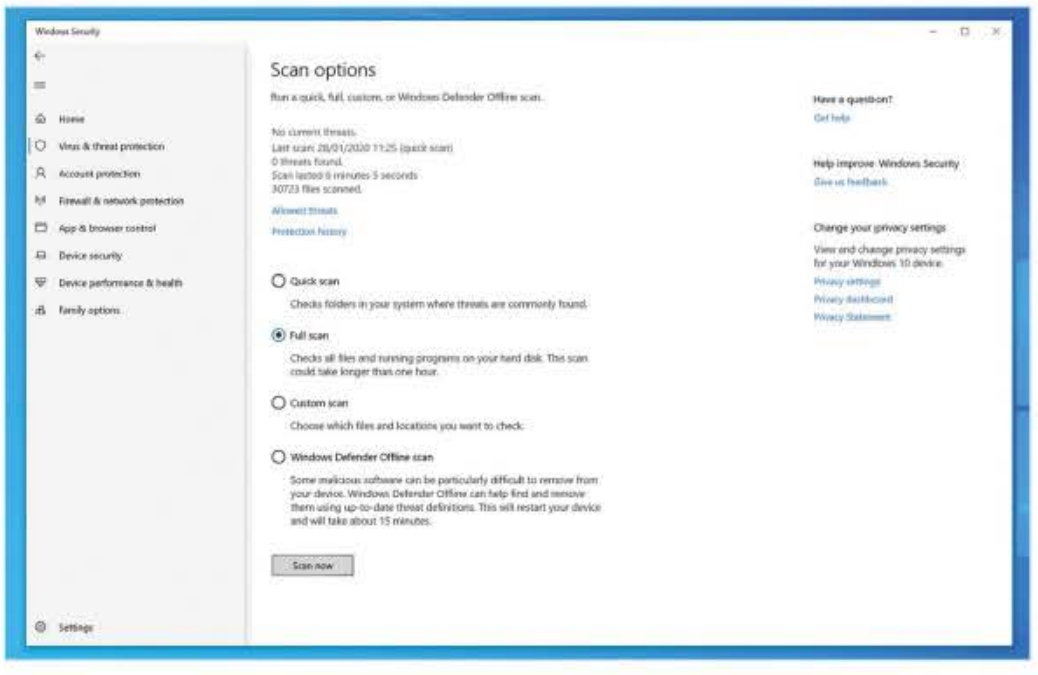
There's a handy function Task Manager has hidden in its box of tricks. When the Task Manager window is open, you should see a tiny square icon with a grid pattern in the bottom-right corner of your screen, in the notification area. It may be hidden in the expanded menu; just click the arrow and drag it on to the taskbar if needed. That icon is a microcosm of your CPU usage, showing a tiny graph that indicates how much of your CPU is currently being utilized, and placing your mouse over it shows exact percentages. To keep it present when Task Manager isn't open, select "Hide when minimized" from the Task Manager's "Options" drop-down menu, then minimize the window.

13 CHECK FOR MALWARE

Of course, ideally you won't have a single bit of malware on your PC, but if you suspect something is amiss (or you watched in slow motion from across the room as your child clicked an extremely dubious link), Windows 10 can scan your system for viruses. Find the "Windows Security" tab under "Update & Security Settings," and select "Virus & threat protection." From this menu, you can run quick security scans on your system, or set up full scans that take longer. Windows Defender automatically scans your system for malware periodically; you can tweak that in this menu, too, check for security updates, and manually input exemptions from Defender's scans. That last point can be particularly helpful for users who deal with a lot of unlicensed software or shareware, but always err on the side of caution when it comes to downloading new programs.



Task Manager has evolved over the years, becoming a powerful system-monitoring tool.



Third-party antivirus software can be a hassle, but Windows Defender is decent and free.

14 USE TASK MANAGER BETTER

Making the best use of Task Manager is key to mastering control over Windows 10. First up, access it faster by right-clicking the "Home" button and selecting it; no need to Ctrl-Alt-Del here. You're also going to want to get rid of the simplified view by hitting "More details" to expand to the full Task Manager experience. Here, you can monitor component usage, view the full suite of active and background processes, and a whole lot more that you won't need to fiddle with. What is useful here is the ability to check exactly how much pressure each program is putting on your CPU, GPU, memory, and drives. If one background app is chewing up CPU power, or you want to compare the RAM impact of two different browsers, this is the place to do it. You can end any task manually by right-clicking it, but be careful—there are lots of background processes that are vital to your system's operation, so don't shut off anything you don't recognize.

15 DISABLE RESUME APPS ON STARTUP

Another matter of preference, here we'll explain how to disable apps and browser tabs resuming upon booting up. If you use your system a lot and have numerous Chrome tabs you want to preserve, skip this step, but otherwise, take a trip into "Accounts Settings." Under "Sign-in options," at the bottom of the page, there's a slider for reopening your apps "after an update or restart." It tries to resume the active programs you had running when you last shut down your PC, potentially including non-essential background processes, and that slows down your PC's boot time. Toggle it off.

16 FREE UP DRIVE SPACE

The less stuff on your drive, the better it runs. This is more true of older hardware, but can also affect SATA SSDs to a significant degree. Clearing up your drive on a semi-regular basis is a good idea, as it can also improve the drive's effective

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lifespan. There's a few ways to do this, which work best when done in conjunction: First off, empty the recycle bin. It's easy to forget about that little white trash can on your desktop, but emptying it regularly is a good idea. Windows 10 also has a built-in disk cleanup tool, found under "Windows Administrative Tools" in the "Start" menu. If you've recently upgraded to Windows 10, this is worth doing; it can safely erase old system files. If you can, move files to a cloud storage solution, such as Google Drive or OneDrive—that can help, too!

17 CHECK YOUR SYSTEM HEALTH WITH PERFORMANCE MONITOR

Another handy tool in Windows 10's repertoire is the Performance Monitor. Activate it by punching "perfmon /report" into the search bar (without the quotes) and give it a few minutes to gather system data. It then spits out a highly detailed interactive report; any major issues with system files or processor loads should be highlighted immediately, and you can also check through a series of system checks and a resource overview, which can identify if one part of your system is working overtime when it shouldn't be.

18 TRACK YOUR TEMPERATURES

There is a multitude of third-party tools that can let you check your system's operating temperatures, but our recommendation would be CPUID's HardwareMonitor app, available for free from www.cpuid.com. Not only does it enable you to track in real time the temperatures of all your PC's components, but it also shows you operating frequencies, voltages, fan speeds, and more. It's a great way to quickly check whether your system is overheating or throttling elsewhere; if you see temps striking above 70 C when your system is idling, it might be time to look into some cooling upgrades.

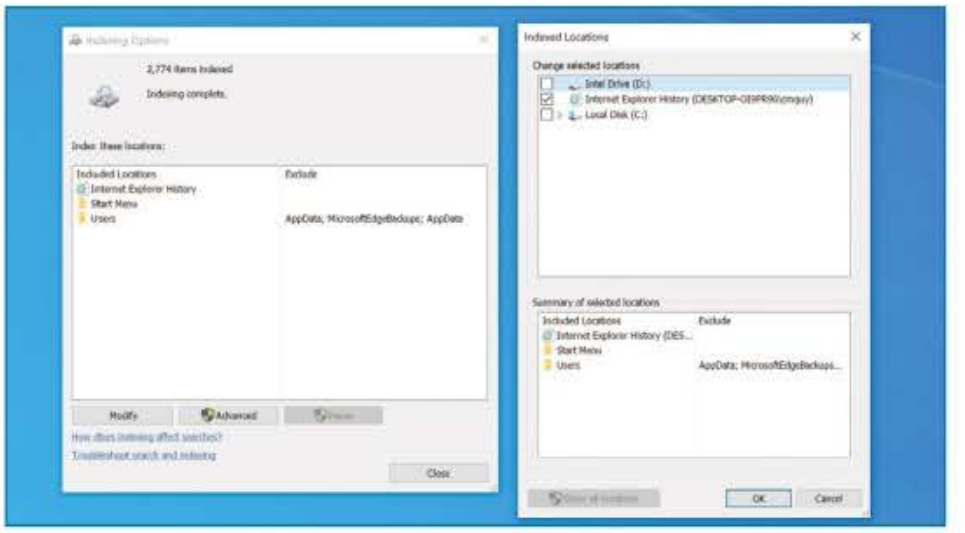
19 DISABLE SYNCHING

Windows 10 has a bit of a digital hard-on for synching everything; whether that's banal things such as appearance themes, or important stuff, such as passwords, search history, and cloud data. If you use Windows on numerous devices, this can be helpful; otherwise, it just puts extra strain on your system, and potentially poses a cybersecurity risk. You can shut off a number of these under "Sync your settings" in "Accounts Settings," but you might also want to disable OneDrive synching, too. To do this, you have to open up OneDrive and head into the settings, then select "Unlink this PC" under the "Account" tab.

20 DISABLE VISUAL EFFECTS

Look, Windows 10 is great, but it's undeniable that some areas are overdesigned. This step does come down to personal preference regarding aesthetics, but it can also be useful if you're running a system with integrated graphics that needs to keep things as simple as possible. Under the "System Properties" menu, there's a tab entitled "Advanced." Hit the "Performance settings" button on this page to open up full customization of all the visual effects baked into Windows 10. Hit "Custom" and you can tweak to your heart's content; you probably won't want to disable everything, but there are some animations here that can safely be turned off.

LOW-END SYSTEM TIPS



Disabling search indexing in Windows is useful on older machines.

21 Use ReadyBoost

Here, we're going to specify tips that are only really useful for older or super-budget systems with limited hardware, such as HDDs instead of SSDs, or less than 8GB of RAM. ReadyBoost is a feature for such PCs, and uses removable storage (typically a USB flash drive or SD card with at least 12GB of storage) to temporarily cache data and speed up your system. You can activate it by plugging in an empty flash drive, right-clicking the drive in File Explorer, and selecting the "ReadyBoost" tab under "Properties." Select "Dedicate this drive to ReadyBoost" and reserve all available space for caching. We advise against using flash drives with data stored on them for this; while it shouldn't be a problem, it reduces the available storage space for ReadyBoost to use, and constantly caching files can reduce the drive's lifespan.

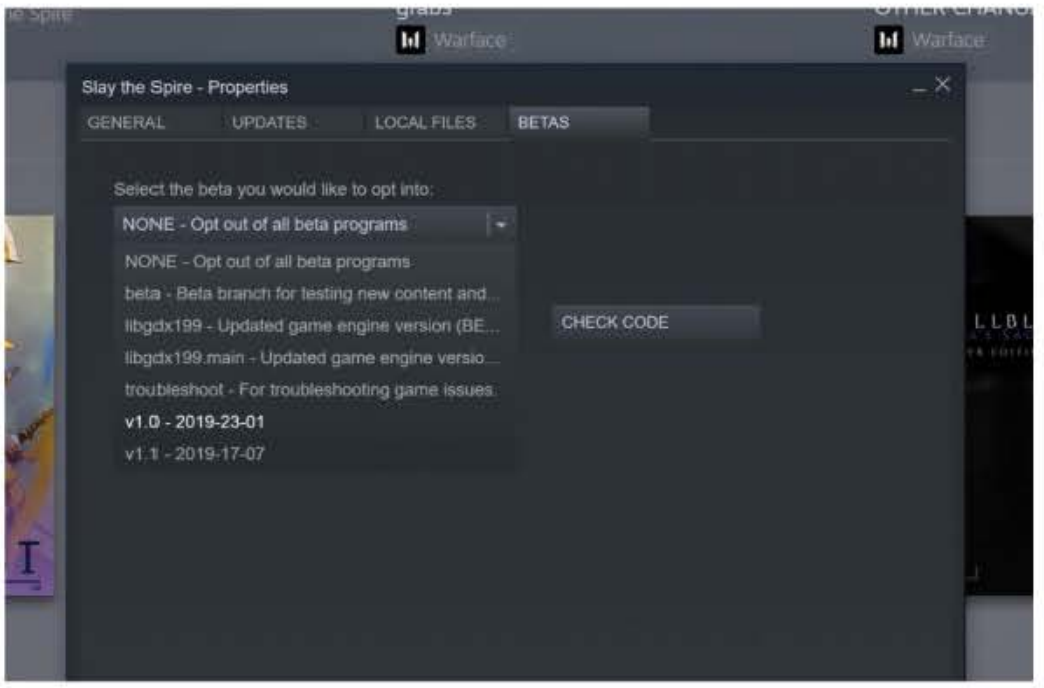
22 Run Defrag for HDDs

If you're still rocking an HDD in your system in 2020 (hey, we don't judge), it's important to remember to defrag that drive now and then, lest long-term fragmentation ruins your data. Fortunately, Windows 10 has a defrag tool built-in, although it's been shuffled around a few times between version updates. Punch "defrag" into the search bar, open "Defragment and Optimize Drives," select your hard drive, and hit "Optimize." Depending on the size of the drive and the degree of existing fragmentation, it could take a while, so leave this until last if you're taking some time to clean up your PC.

23 Disable Search Indexing

Windows 10's search function is great, but the indexing process can be fairly resource-intensive on older (or super-budget) systems. Access the indexing menu by searching for "indexing options" in the Control Panel, hit "Modify," then hit "Show all locations." If you want to fully disable indexing, select everything here, and click "OK." This stops Windows Search from indexing your results, freeing up system resources to speed up your PC.

OPTIMIZE WINDOWS FOR GAMING


Warface
Warface
Slay the Spire - Properties
GENERAL
UPDATES
LOCAL FILES
BETAS
Select the beta you would like to opt into:
NONE - Opt out of all beta programs
NONE - Opt out of all beta programs
beta - Beta branch for testing new content and...
libgdx199 - Updated game engine version (BE...
libgdx199.main - Updated game engine versio...
troubleshoot - For troubleshooting game issues
v1.0 - 2019-23-01
v1.1 - 2019-17-07
CHECK CODE

24 DISABLE HARDWARE ACCELERATION ON MOUSE

If you're a serious gamer, you've probably done this already. Hardware acceleration for computer mice smooths out the overall pointer experience by making your cursor move further if you move the physical mouse faster, but this can be ruinous in first-person shooters, where snap movements to aim at a target can overshoot their mark. Hop into the Control Panel and select "Hardware and Sound," then find your mouse settings. Under "Pointer Options," you can deselect "Enhance pointer precision"—this is what Windows 10 calls in-OS hardware acceleration. You can tweak baseline mouse sensitivity here, too, although we recommend doing that via the physical DPI controls on a gaming mouse.

Steam has plenty of interesting beta tools that are worth checking out.

25 BLOCK AUTO-UPDATES IN GAME LAUNCHERS

This is a must-have, particularly if you're on a metered Internet connection. Steam is easy enough; select "Downloads" under "Steam Settings," and toggle the settings to your heart's content. In particular, we advise unchecking "Allow downloads during gameplay" if you play online games. Origin and Epic don't have quite the same array of choices, but do still allow for blocking auto-updates; Epic even allows you to tweak update choices on a per-game basis.

26 REVERT GAME VERSION

This is a somewhat niche tip, but it can be a lifesaver if an update tanks one of your games. Steam has a beta feature—not available in every

REACH FOR YOUR WALLET

31 Upgrade Your Drive

SSD storage used to be expensive, but nowadays affordable SATA SSDs are commonplace. Even smaller M.2 drives (around 120GB) are quite cheap, with models from reputable manufacturers costing as little as $25. Using one of these as a main OS drive guarantees faster boot times, and there's no need to get rid of your old drives; they can become bulk storage for files that don't need to be rapidly accessed. Note: Win 10 takes up at least 20GB, so buying a really tiny M.2 drive isn't a great plan.

32 More Memory

If your system is running slow, upgrading the RAM can often provide that extra bit of oomph it needs. It's also one of the easiest components to upgrade, especially if your system has excess DIMM slots. For modern systems, 8GB of memory should be considered the absolute minimum amount, with 16GB working perfectly well for most tasks. If you use video-editing or rendering software on the regular, though, upgrading to 32GB or even 64GB might be a good call.

33 Move Beyond Integrated Graphics

Rocking a new budget system with integrated graphics is no bad thing; modern APUs are great, and with Intel's 10th-gen Iris Plus chips headed to desktop (eventually), integrated graphics are in a great place right now. However, if you're still rocking an older dual-core APU, it might be time for an upgrade. That could just mean jumping up to a newer processor (such as AMD's excellent Ryzen 5 3400G), or it might mean getting a GPU. Snap up a Radeon RX 550 for under 100 bucks, or aim a little higher and snag something like an RX 570 or Nvidia's trusty GTX 1050 Ti—neither should break the bank, but will smash integrated graphics on older APUs.

Upgrading to an M.2 drive is ideal, but SATA SSDs are still good.

© MICROSOFT

game, but it's easy to check—that allows you to roll back your game version to a previous update. Right-click the game in your library, select "Properties," and navigate to the "Betas" tab. From here, you can opt in to older versions of the game in the drop-down menu, let the game update, and boom—you're running a previous update. It doesn't work for most online multiplayer games, of course; you need to be running the same version as everyone else.

27 DISABLE FOCUS ASSIST

This is the big one: Get rid of Focus Assist. Have you ever been midway through a high-stakes online match, only to be yanked out of it as Windows tabs you back to the desktop to inform you that you've received an email from your co-worker? Yeah, that's got to stop. Find the "Focus Assist" tab under "System Settings," and slap it to "Alarms only"—there's no option to turn it off completely, but you can also disable it during gameplay or screen sharing. Lastly, you can deactivate the option to show you "what you missed" when you return to the desktop; an unnecessary irritant, for our money.

28 KEEP YOUR GPU DRIVERS UP TO DATE

Another potentially obvious tip for gamers is to keep your GPU drivers up to date. No, that doesn't mean installing GeForce Experience—the clutter-free way to do this is simply to head to the manufacturer's website and locate the most recent drivers for your GPU. Both AMD and Nvidia have handy search functions to help you find your exact GPU, and what drivers it needs. Remember to select the "Game Ready" drivers if you're using a newer Nvidia card, rather than the "Studio" version.

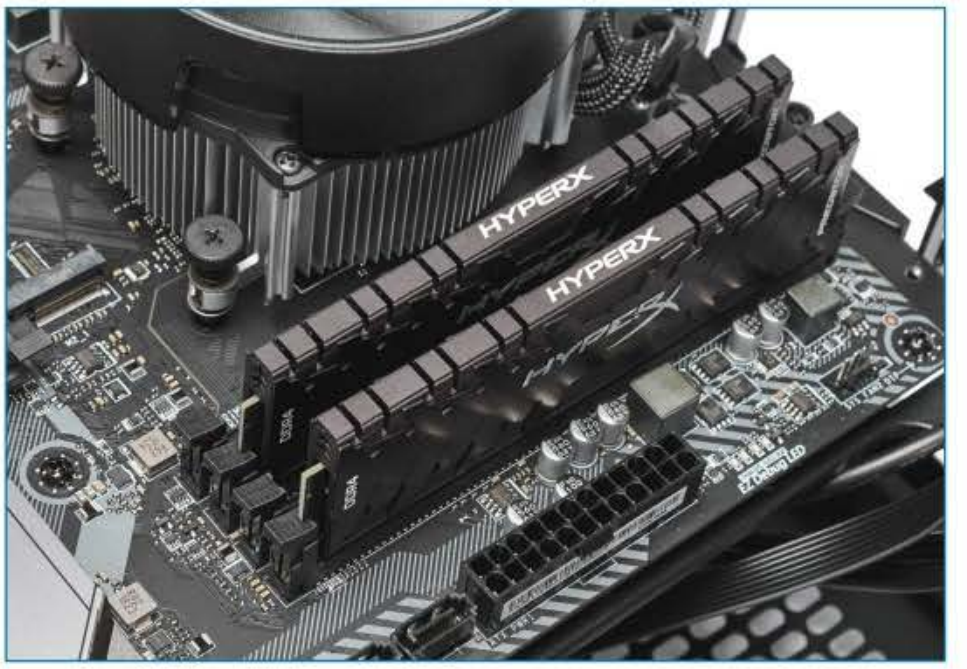
29 ENABLE GAME MODE

A simple change to make, although it isn't likely to improve game performance by much on most systems. Under "Gaming Settings," find "Game Mode." Make sure this is toggled on and your PC will manage temperature and available memory better to (theoretically) improve frame rates in games. While we're not sure it really boosts frame rates, it does also block Windows Update from doing anything while you're in-game. It's possible that some games see more stable frame rates—perhaps Microsoft's own stuff, as Game Mode is officially listed as an Xbox-branded tool.

30 INSTALL DIRECTX 12

You might already have DX12 installed, but there's an easy way to check if you do have the latest version of the widely used Microsoft API tool. Hit the Windows key and R to open the Run function, then type "dxdiag" (again, no quotes), and hit Enter. This should bring up the DirectX Diagnostic Tool; on the bottom of the page, it shows you which version of DX you have installed. If DX12 isn't installed, go check your Windows Updates!

FAKE NEWS WHAT NOT TO DO...



While RAM disks sound cool, their applications are niche at best.

34 Don't Defrag an SSD

Defragmentation software can be helpful, but only for older drives. If you have a SATA SSD or M.2 NVMe drive, you don't want to try defragging it; there are no significant performance benefits (because SSDs have no moving parts, there's no risk of mechanical latency building up over time), and the lengthy defragmentation processes can actually wear out the memory cells and ruin the drive's lifespan if you do it too many times. Just don't bother.

35 RAM Disks Aren't That Useful

Also known as RAM drives, these nifty data storage solutions use third-party software to partition a given amount of your memory to be used as data storage instead of random-access memory. The advantages jump out immediately; RAM is a lot faster, netting you vastly improved data transfer speeds for your virtual drive. If you're moving files around a lot and only have an HDD or SATA SSD, it seems like a no-brainer. However, RAM disks are volatile memory; if your PC loses power, that data is wiped. It's necessary to have regular automatic backups to your physical drive, and to reload the RAM disk image back into your memory every time you boot up your system, which takes time. Unless you have a staggering amount of memory to spare, it just isn't worth it.

36 Don't Tweak Power Plans on Desktop

Simply put: There's no point. If your PC is connected to mains power, set the power plan to high performance and call it a day. Some people will claim that there are benefits to using the other plans; we're not saying those people are wrong, but we are saying that any benefits will be practically unnoticeable.

37 Don't Reinstall Windows

A complete fresh install of Windows should only ever be a last resort, when other attempts to salvage your system have failed. System restore points are a more useful resource, and it's generally a good idea to have both cloud-based and physical backups of your data. Reinstalling Windows is often like bringing a broadsword to a knife fight; effective, but far too much effort and potentially messy.

Introduced in Turing cards, DLSS promised better images via machine learning. **PHIL IWANIUK** plumbs its depths

INTO THE

As sales pitches go, Nvidia's deep learning supersampling (DLSS) is as revelatory, and preposterously sci-fi, as it gets. Specific cores dedicated to machine learning, harnessing bleeding-edge algorithms, take resource-friendly 1440p resolution images and blow them up to super-sharp 4K proportions—and all without the performance hit of actually running at that higher resolution in the first place.

Along with that quietly revolutionary real-time ray tracing capability, DLSS was the big selling point of Turing cards. But while the advantages are real, and available to you in a generous swathe of games, its uneven execution from title to title is confusing. In its worst moments, it's been capable of actually making your game look worse when enabled than in the original native resolution.

But the teething problems might prove trivial when we look at deep learning's potential to turn graphics rendering on

© SQUARE ENIX

its head. Just as real-time ray tracing's proved to be what some might call a soft launch, offering tantalizing glimpses of its promise amid the noise of patchy game support and performance issues, so it goes with DLSS. For owners, it feels like being in on the ground floor on an important new advancement, and having to deal with adjustment inertia from software developers and driver writers.

Before we can really assess what deep learning might do for our gaming rigs in five or ten years' time, it's important to pin down what exactly's happening in those Tensor cores, why it differs from temporal antialiasing methods or downsampling, and how it makes the games of 2020 look and perform. And to do that, you have to weigh the marketing talk against the look and feel of games such as *Control* and *Metro Exodus*, frontrunners in DLSS implementation. First, the fundamental premise: What's going on inside Nvidia's Tensor cores?

This much is clear: Nvidia's been working on deep learning for many years now. Current technical director of deep learning, Andrew Edelstein, has been operating in that capacity since 2010, and for years the company's CEO, Jensen Huang, has been demonstrating a deep-learning neural network demo on the trade show circuit in which a computer identified pictures of cats and dogs. The more pictures it examined, the more accurate it became.

Despite its interest and investment in this area for over a decade, it wasn't until 2018 that deep learning was successfully applied to rendering a 3D environment. That breakthrough came via a conditional generative neural network that could interpret video footage of real locations and turn them into 3D environments. VP of applied deep learning Bryan Catanzaro's research team captured dashcam-style video of cars driving around several cities, then identified the "high-level semantics" of each scene—using Unreal Engine 4 to colorize the objects and scenery elements, and teaching the network what a car is, what street lights are, what kerbs look like. Once that was established, the network could correctly identify them independently in future video footage, just like the AI that picked out cats and dogs.

The end result isn't a simplistic environment, either. The busy downtown streets are packed with recognizable cars, each one a different real-world model, just as you'd see if you were unfortunate enough to find yourself in a real traffic jam. Beyond them are trees and skyscrapers, and it's possible to drive through the environment as if it were just another urban circuit in a racing game. (Naturally, the authors of this tech were quick to put it to other tasks. One fed the learning AI footage of people dancing "Gangnam Style" to render a 3D scene of their colleague doing a very convincing rendition.) It's undeniably impressive to see such a vivid 3D environment rendered intelligently by a machine that only had flat video data to build it from—but it

Remedy's *Control* has some of the best DLSS around. Here it's upscaling a 2560x1600 image...

***Control's* real-time ray tracing makes it an especially demanding title, even for RTX cards.**

THE ALTERNATIVES

Just as there's more than one way to part a feline from its outer wrapper, rendering an image to give the appearance of a higher resolution than it's running at has a few methods. One of them is checkerboard rendering, often found in 4K versions of console games. This involves rendering half the scene, then (in simplified terms) filling the other half using the last frame's data. The performance gains against rendering the whole scene are obvious—the hardware renderer is essentially given half the task within the same time frame versus producing a full higher resolution image. This allows systems whose hardware couldn't output 4K images at a playable frame rate to "cheat" by checkerboarding.

Then there's supersampling antialiasing, which despite its high computational cost, is as old as the hills—load up your favorite games from the noughties, and you may well see an SSAA option somewhere in the

© REMEDY ENTERTAINMENT

...and here it's running that resolution natively. The visual difference is very subtle, but accounts for a 15fps change.

bears repeating that this only happened in 2018. This is still very new technology.

THE BIG PICTURE

The roll-out of current-gen RTX Turing cards took things a step further with DLSS. The big picture involves, appropriately, a lot of really big pictures. Specifically, it involves showing thousands of screenshots of a supported game to a neural network like those described above. In this case, the screenshots act in the capacity of the drive-along video footage, or the cats and dogs, but they're supersampled 64 times bigger than the original image. That's 64x SS. Anyone feeling smug about running *Red Dead Redemption* with 8xMSAA, sit back down.

Another version of those same images, without any antialiasing, is also fed to the neural network, and it's then programmed to contrast and compare them like a superintelligent high schooler sitting their English Lit exam. In this case, instead of learning how to hold down a job at Target and shake down its parents for cash when things get tight, it's learning how to approximate the x64 SS image without the massive computational hit of doing that process verbatim. This preliminary work all happens long before you load up the game, which like the relative novelty of the tech, is worth bearing in mind later on as we examine its implementation so far.

As the learning AI repeats this process, over and over, it gets better at it, modifying its algorithms until it automates the process and reaches a visual result that looks like a 64x supersampled image, without any blurring, ghosting, or glitched-out transparency effects. The fruits of all that labor are then taken from the supercomputer, written on to Nvidia's game-ready drivers, and handed to your RTX graphics card. That saves your system from the computational tasks of an actual deep-learning supercomputer: handy. With the knowledge of precisely how to approximate supersampled images of your game now available, the card's Tensor cores interpret it, and put it into action in a way that traditional GPU architecture couldn't. Theoretically, that means if your desired final image quality is 4K, you can drop down the rendering resolution to 1440p, and enjoy the reduced performance cost that comes with it, then ask DLSS to enlarge the image back to 4K.

TEETHING PROBLEMS

Perhaps the most important thing to note about that whole process is the very first step: feeding the supercomputer images

graphics menu. Here's how it works: An image that's bigger than your native resolution is rendered, then the renderer takes an average of several pixels' color values, and applies that to one pixel in the final frame, giving the impression of a much higher-resolution image. It's not a million miles away from DLSS, but minus the aid of deep learning.

You've likely heard of or even employed "downsampling" to achieve higher resolutions than your monitor's native output, too, and essentially this is just another form of SSAA. Ordered grid supersampling antialiasing, to be precise. The distinction here comes down to the pattern used when sampling pixels to take an average and shrink the larger-resolution render back down to your monitor's native resolution. In this case, ordered grid SSAA examines the entire object, not just the edges, which are prone to visible jaggies, and this creates a higher fidelity final image than other antialiasing methods.

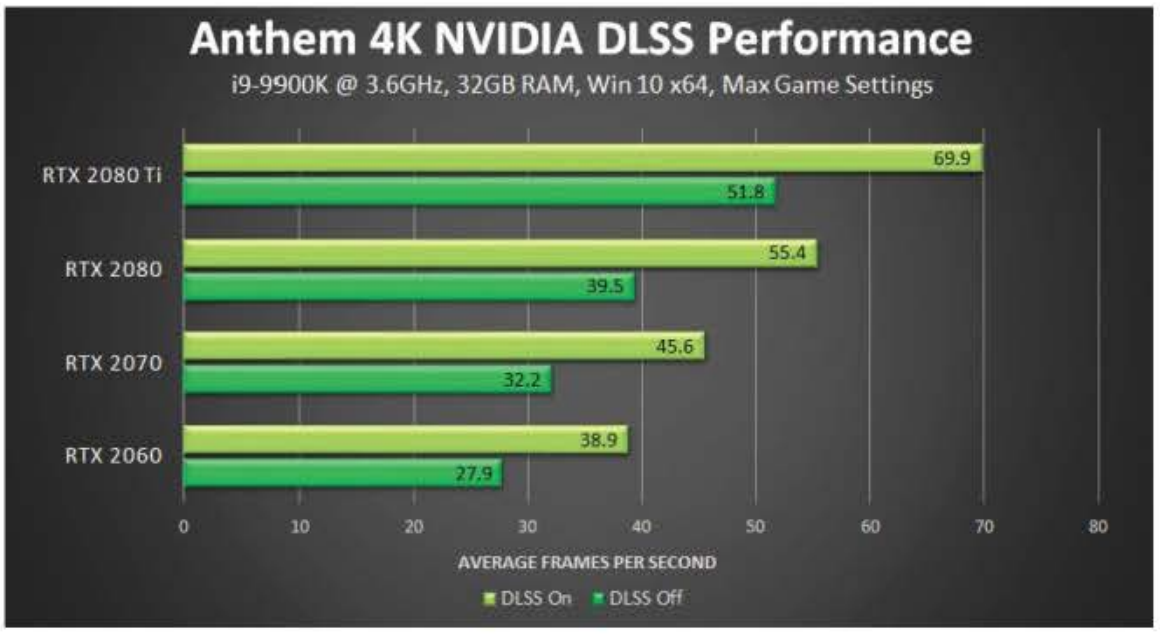
of a game so that it can recognize the jaggies and devise a "perfect" next frame. If the associated game-ready driver is to be released in tandem with the game, this requires access to the final code ahead of time, plus however long it takes the supercomputer to refine and automate this process, then for the driver team to harvest the data and bake it into the driver files. Nvidia hasn't publicly detailed how long any of these processes take. It might be weeks from launch, or it might be months. Either way, this was never going to be a fire-and-forget graphics option that worked perfectly in the first supported game you tried an RTX card on.

There are three big variables at play in any game and its associated DLSS effectiveness. The first is the game engine itself. Although Unreal Engine is increasingly ubiquitous on the gaming landscape in 2020, there are plenty of exceptions. *Doom Eternal* continues the proud tradition of bespoke id game engines with id Tech 7. Unity still has a presence, particularly amongst 3D indies. Cryengine V has several high-profile games on its roster, including *Hunt Showdown*, and Amazon Lumberyard will surely get its coming of age moment with a big release soon (nobody's counting *The Grand Tour Game).* Every game engine has to be interpreted slightly differently by Nvidia's deep-learning supercomputer, and the absence of a one-size-fits-all solution introduces complexity, increases the likelihood of errors, however tiny, and increases variance in results.

The next variable is obvious enough: complexity of content, to use Nvidia's own terminology. It's harder to approximate a supersampled frame from *Metro Exodus* than in *Quake II.* There are more surfaces, more transparency and lighting effects to figure out and disregard as aliased lines. And while that's a pretty academic comparison, considering the general fidelity level of PC releases in 2020, it illustrates a point. Games with more densely populated scenes are going to need more help from DLSS to achieve the desired final image. Genre plays a bit part in variance here, too—compare a racing game like *Assetto Corsa Competizione,* where you're either looking at a whole lot of cockpit or your own car's exterior, then opponents' vehicles and comparatively sparse track environments, to an atmospheric action game such as *Control,* whose every room is bustling with incidental objects, architectural flairs, and high-poly characters.

The third is perhaps the most significant: the time spent training the

Metro Exodus. **Whisper its name in the company of graphics cards and you'll hear a gasp of fear.**



The performance benefits of DLSS are clear, but can you live with the potential fidelity hit?

THE SUPPORTED GAMES

As academically interesting as it might be, DLSS doesn't count for much unless the games you play actually support it. There may not have been a raft of essential titles ready to push your RTX card's new features to its limits at launch, but now, at least, there's a total of 30 current or upcoming DLSS-supported games. Some examples, such as *Final Fantasy XV Windows Edition,* have added the support post-release, while others, such as *Metro Exodus,* shipped with a version of DLSS that seemed to degrade the overall image sharpness, but thanks to later refinements and patches, works very differently, producing a sharper image with DLSS enabled—just as intended. Then there are forthcoming releases such as *Bloodlines 2,* which have had the benefit of seeing other games' implementation of DLSS, and the ability to learn from them.

© DEEP SILVER, NVIDIA

***Metro Exodus* produced a horrible blurring effect with DLSS at launch, but after several patches, it's now much better.**

supercomputer itself to produce the data that your Tensor cores can use in the driver. As with all machine learning, and indeed all the learning we undertake with our own brilliantly fallible human brains, repetition is key, and the more time Nvidia's supercomputer has to analyze images, the better the results. The proof personified of this facet is in the dramatic improvement of DLSS implementation in games such as *Metro Exodus* from launch day to present. Had you checked the DLSS box back in February 2019, you would have been met by a very blurry image, dramatically lower fidelity than the equivalent native resolution image, then you would have probably unchecked the box, and mentally thrown DLSS on to the same trash pile as 3D monitors, that *ET* game, and Google Plus, never to think about it again. It's understandable. Complete that same process today, and you see an unrecognizable result: very convincing supersampling, with few noticeable artefacts, and a minuscule performance cost versus running at that larger resolution.

USER CONTROL

Perhaps another reason gamers haven't fully embraced DLSS is its narrow range of control. Most games offer a very limited number of render and final resolutions, and in some cases, such as *Anthem* or *Shadow of the Tomb Raider,* exist only as a checkbox in which the game developers or driver writers decided upon an internal resolution that DLSS would start from and build up a bigger image around. Those parameters varied between RTX GPU models, too, so your internal resolution of the same game on an RTX 2070 and 2080 Ti might be totally different. That's confounding for the consumer, and it undersells the power of the technique. But it worked this way at launch for several titles to actually preserve performance.

If your GPU isn't being taxed much in the first place, increasing the resolution the old-fashioned way results in a faster frame render time than utilizing the Tensor core. DLSS is designed to lighten to load when the GPU really has its back to the wall, and the Tensor cores require a fixed amount of time to run their neural network algorithms, so if you're already enjoying high frame rates, DLSS won't help. That fixed proportion of each frame render time might actually hurt performance if it's well above 60fps—although, again, Nvidia hasn't specified exactly how long Tensor core DLSS operations take, so we can't pin down a tipping point in FPS when it becomes redundant.

None of this is easy to convey succinctly in a graphics options menu, so the decision was made to restrict the internal resolution, and prevent gamers from hamstringing themselves inadvertently by enabling DLSS in situations they didn't need it in. As the technique and game support have matured, we're seeing some of the control options expand.

Control, aptly enough, proves a fine example. Check the DLSS box to enable

- **Anthem**
- **Ark: Survival Evolved**
- **Atomic Heart**
- **Battlefield V**
- **Darksiders III**
- **Dauntless**
- **Deliver Us The Moon: Fortuna**
- **Fear the Wolves**
- **Final Fantasy 15**
- **The Forge Arena**
- **Fractured Lands**
- **Hellblade: Senua's Sacrifice**
- **Hitman 2**
- **Islands of Nyne**
- **Justice**
- **JX3**
- **KINETIK**
- **Mechwarrior 5: Mercenaries**
- **Metro Exodus**
- **Monster Hunter World**
- **Outpost Zero**
- **Overkill's The Walking Dead**
- **PlayerUnknown's Battlegrounds**
- **Remnant: From the Ashes**
- **SCUM**
- **Serious Sam 4: Planet Badass**
- **Shadow of the Tomb Raider**
- **Stormdivers**
- **Vampire: The Masquerade – Bloodlines 2**
- **We Happy Few**

the technique, and you'll find "Resolution" and "Render resolution" parameters. This allows you to decide on both the smaller internal render resolution, and the upscaled end result, and in addition to the refinement of DLSS's end result, borne of many thousands more images being fed to the deep-learning supercomputer since launch, this makes it easier to understand what it's doing. In *Control,* it's also possible to edit the config.ini file and manually set your render resolution anywhere between the final resolution and one quarter of it. Despite the risk of a performance hit, you can even manually set DLSS to upscale just slightly from your internal resolution, so it functions more like temporal AA; the image quality might be better, but it's unlikely to perform that process faster than the game's TAA option itself.

EA's *Anthem* was another flag-waver for DLSS, but it produced an overly glossy effect.

SKYNET AND BEYOND

It's clear that using DLSS to target a 4K image isn't the same as running a game at 4K in the first place. Even after plenty of post-release support on *Control, Metro Exodus,* and others, the difference is clear. But DLSS shouldn't be characterized as a failure, not least because of the ways it might be better used in the future.

One of those pertains to ray tracing, the other Turing headline act. Anyone brave enough to have enabled it in-game knows the associated performance cost, and that cost grows in direct relation to resolution. If we can use DLSS as a smart upscaling tool, ray tracing doesn't have to be a PC-melter, but a technique available to the masses. That makes it more attractive to game devs for broader implementation, and as that knowledge base grows for how to implement it, the ray tracing we see in-game improves. Win-win.

Virtual reality might prove to be DLSS's real redemption moment, though. Simply because our eyes work in a way that focuses on a central point, we don't actually need to see the entirety of an image in high resolution. You could lower the resolution of the area covered in our peripheral vision, and our eyes wouldn't notice, because our peripheral vision is a kind of "low-res" sight in the first place. VR headsets, where our eyes are incredibly close to the screen, is the ideal guinea pig for adaptive resolution based on our focus point, and DLSS might yet prove to be the breakthrough.

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techradar.

A BRIEF HISTORY OF MACHINE LEARNING

However advanced artificial intelligence might be, ultimately it's still based around the workings of our own brains. Machine learning's no different—initially devised based on a model of brain cell interaction in Donald Hebb's 1949 book *The Organization of Behavior,* the earliest model focussed on our own neurons' changes in properties when repeatedly activated together, creating pathways, and extrapolated an artificial system built around those same behaviors. Light bedtime reading it certainly is not.

IBM's Arthur Samuel started work on a computer program designed to play checkers shortly after, in the early 1950s. With very little to work with in the way of computer memory, Samuel had to design a degree of independence into the program, assigning scores to each position on the board and their chances of scoring points. This program also remembered all the positions it had previously been on. It's believed that Samuel also coined the phrase "machine learning."

Cornell Aeronautical Laboratory's Frank Rosenblatt combined these two ideas in 1957 in a machine that went by the name Perceptron, beautifully typical of its era. Perceptron enjoys the accolade of being the world's first successful neuro-computer; however, it failed in its intended purpose of pattern recognition in images, such as faces. Research and enthusiasm for machine learning faded thereafter.

From left to right: **IBM's Arthur Samuel; Cornell Aeronautical Laboratory's Frank Rosenblatt; the Perceptron supercomputer, pictured here looking like two open drawers of vermicelli.**

However, the "nearest neighbor" algorithm paved the way for basic pattern recognition in 1967, and while artificial intelligence continued on a trajectory of knowledge-based programming, machine learning research bubbled away in the background with the new directive to solve practical problems, rather than simply training AI.

Three major breakthroughs in the '90s and '00s teed up our current age of advanced machine learning—firstly "boosting" algorithms in 1990, which minimized bias during supervised learning, then speech and facial recognition, driven by the mobile communications tech boom. Now we reach its apex: making our games run better.

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Linux Command-Line *Tips & Tricks*

Take your knowledge of the Linux Bash shell beyond the basics with *Nick Peers*

THERE'S NO EXCUSE not to school yourself in the ways of Linux command-line operations. Whether you're accessing the Terminal on your Linux desktop, logged directly into the Bash shell, or intrigued by Windows 10's support for CLI-based Linux distros, you've come to the right place. We're going to assume you know the basics of Linux's Bash shell and command language—check out our August 2017 edition (Vol. 22, No. 9) for a starter's guide if you need it—but as a quick reminder, Bash uses a relatively straightforward syntax for each command:

```
$ utility command -option
```

The `utility` portion of the command is the tool you wish to run, such as `ls` for listing the contents of a directory, or `apt-get` for triggering the package management tool.

The `command` section is where you specify exactly what you want the utility to do. Typing `apt-get install` instructs the package management utility to install the named package, such as:

```
$ apt-get install vlc
```

The `-option` section is where one or more "flags" can be set to specify preferences. Each flag is preceded by one or two dashes, and the most useful is the `--help` option, which gives a description of the utility, plus available commands and options. Utilities can be run on their own, with a single command or flag, or as a combination of the two.

With this basic framework in place, you're ready to start exploring how you can interact with Linux via the command line—for Windows users, this introduces the intriguing possibility of being able to run Linux CLI apps and services on your PC without installing a virtual machine or dual-boot setup.

In this feature, we're going to look at some more advanced uses of the Bash shell, from the practical (work with permissions and interrogating your hardware) to the more whimsical—surf the net directly from the shell, plus play music, and have some fun with ASCII art into the bargain. In between, you'll learn various tips and tricks to speed things up. Enough chit-chat, it's time to paddle into the slightly deeper waters of more advanced Terminal usage. Don't worry, the water's still warm....

Thu 09:46

Terminal

nick@nick-VirtualBox: ~

File Edit View Search Terminal Help

```
nick@nick-VirtualBox:~$ sudo lshw -short
[sudo] password for nick:
H/W path      Device      Class      Description
=====================================================
                          system     VirtualBox
/0                        bus        VirtualBox
/0/0                      memory     128KiB BIOS
/0/1                      memory     7976MiB System memory
/0/2                      processor
/0/100                    bridge
/0/100/1                  bridge
/0/100/1.1                storage
/0/100/2                  display
/0/100/3      enp0s3      network
/0/100/4                  generic
/0/100/5                  multimedia
/0/100/6                  bus
/0/100/6/1    usb2        bus
/0/100/6/1/1              input
/0/100/7                  bridge
/0/100/b                  bus
/0/100/b/1    usb1        bus
/0/100/d                  storage
/0/3          scsi1       storage
```

```
nick@NICK-PC:~$ w3m www.maximumpc.com
nick@NICK-PC:~$ figlet Maximum PC rocks!
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nick@NICK-PC:~$ figlet -t Maximum PC rocks!
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nick@NICK-PC:~$
```

LET'S OPEN WITH something that Linux is hot on: file and folder permissions. There's a great primer if you need it at https://help.ubuntu.com/community/FilePermissions, where you'll get an overview of how file permissions are displayed and how they're applied to three levels: the file or folder's owner, a specific user group, and then everyone else.

You can see a folder or file's current permissions (and its owner) by typing `ls -l`. You'll see 10 characters representing the permissions: The first character denotes whether the item is a file (`-`) or folder (`d`), and the other nine can be split into three lots of `rwx`, with `r` denoting read access, `w` write access, and `x` execute access to the file for the owner, the file's group (so all users assigned to that group), and finally everyone else.

A file or folder's permission can be changed using `chmod`, which assigns numbers rather than letters to denote the levels of file access (navigate to the file or folder's parent directory first). Use `sudo` if you're not the file or folder's owner:

```
$ chmod 777 filename
```

Substitute `filename` with the name of the file or folder you wish to apply the attributes to. When it comes to setting folder permissions, you'll usually want to apply the same permissions to its contents—including subfolders. Here, the recursive option (`-R`) comes into play:

```
$ chmod -R 777 folder
```

The key element is the number, which refers to the permissions you're setting, one each for the file owner, file's group, and everyone else. These are typically one of: `4` (`r--`, read only), `5` (`r-x`, read and execute—for programs), `6` (`rw-`, read/write but no execute), and `7` (`rwx`, full access). So, assign `644` to a folder or file and you're giving the owner read and write access, but restricting all others to read-only access. Set `775` and you're giving the owner and group full access, while anyone else can read and execute the file only.

A related tool to `chmod` is `chown`, which is used to change the owner or group of a file or folder, like so:

```
$ sudo chown user file
$ sudo chown :group file
```

Again, the `-R` option can be used to change the owner of a folder and all its contents. Use `chown` with care—if you get your path wrong, you could inadvertently screw up your entire filesystem.

Get Hardware Info

The following tools, all prefixed with `ls`, are designed to reveal information about your computer's hardware. Note: They're of most use to those running Linux natively—many don't work or display much useful information from the Windows Linux subsystem. Let's start with the `lshw` utility:

```
$ sudo lshw -short
```

This provides a barebones summary of your hardware, while `sudo lshw` goes to the opposite extreme (issue `sudo lshw -html > sysinfo.html` to create a summary file you can open in a web browser).

Other `ls`-based tools include `lscpu` (for detailed CPU information), `lsblk` (drive information), `lspci` (internal hardware), and `lsusb` (external peripherals). With the latter two, add the `-v` option to provide more detail, and invoke them using `sudo` to ensure you have full access to your system.

Another tool to consider is the `dmidecode` utility, which takes the information listed in your PC's BIOS, such as maximum supported memory and fastest CPU your motherboard can handle, and presents it in a more user-friendly format. It's best used in conjunction with the `-t` switch, which enables you to focus the tool on a specific part of your PC's hardware—for example:

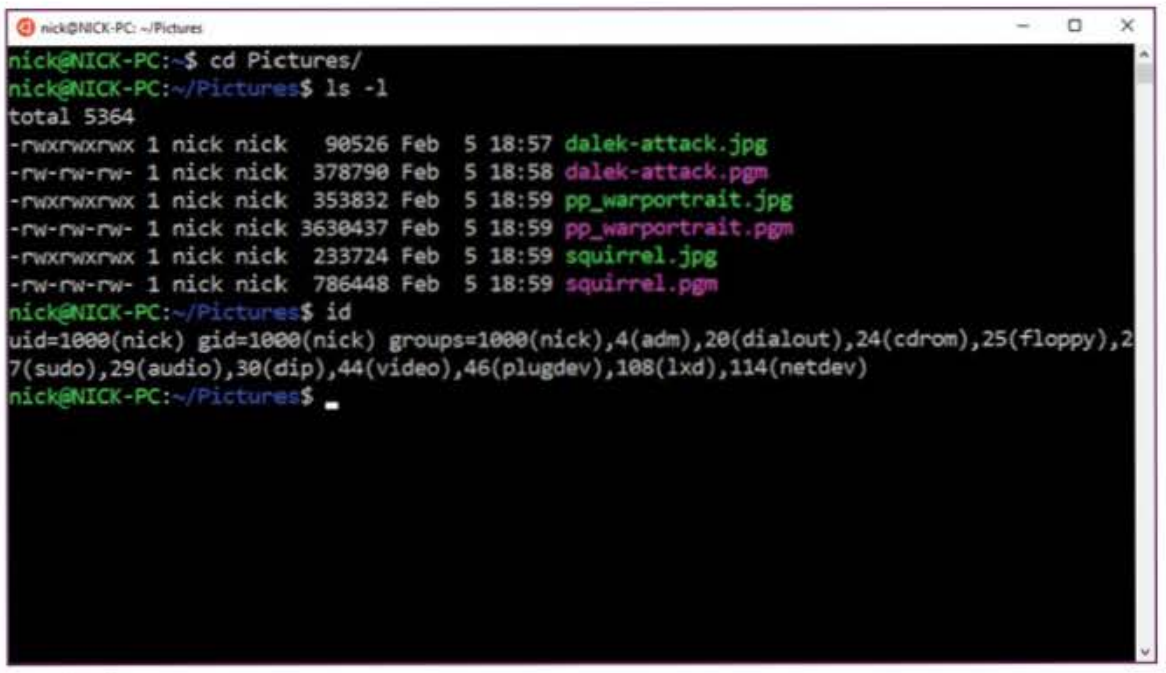
```
$ sudo dmidecode -t bios
```

The `bios` option reveals key information about your mobo, including what capabilities it supports (such as UEFI, USB legacy, and ACPI), plus the current BIOS version, including its release date. Other supported keywords include `baseboard` for identifying your motherboard make, model, and serial number, `processor` (check the "Upgrade" field to see what kind of socket it's plugged into), `memory`, and `chassis`.

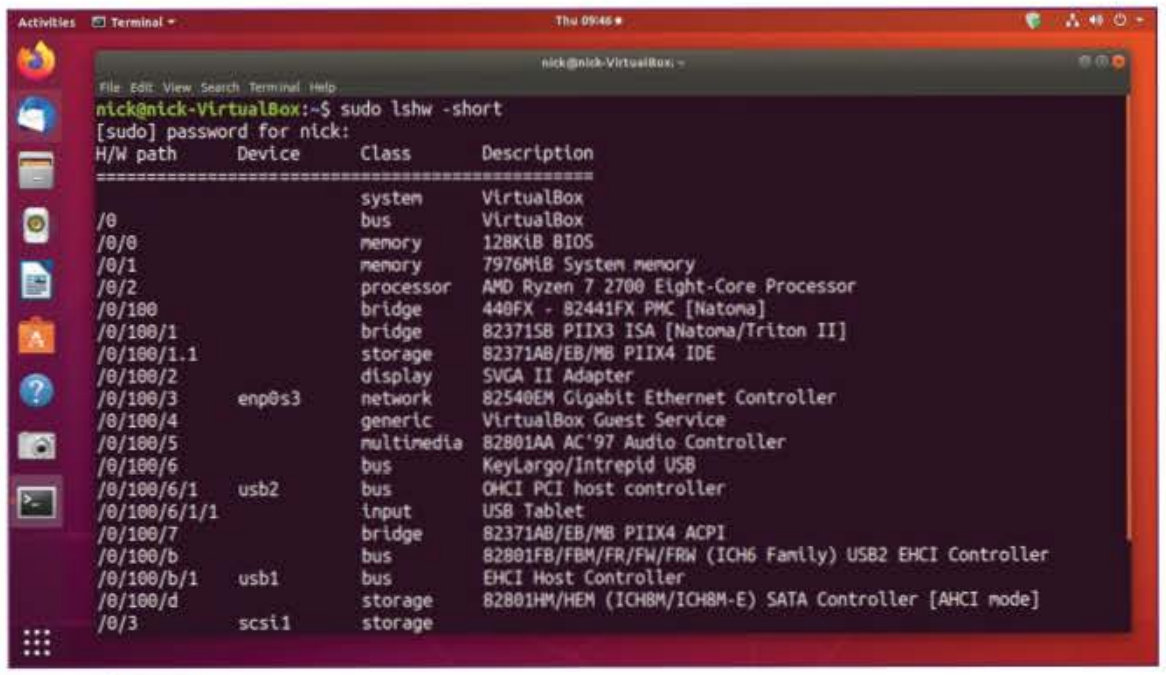
One word of warning: The DMI tables that contains this BIOS-related information aren't always accurate, so while `dmidecode` is a potentially useful resource, don't be surprised if certain things (like installed RAM) don't stack up.

Get Driver Information

Many hardware issues can be traced to drivers (or modules, in Linux parlance). Another tool for displaying these modules


nick@NICK-PC: ~/Pictures
nick@NICK-PC:~$ cd Pictures/
nick@NICK-PC:~/Pictures$ ls -l
total 5364
-rwxrwxrwx 1 nick nick 90526 Feb 5 18:57 dalek-attack.jpg
-rw-rw-rw- 1 nick nick 378790 Feb 5 18:58 dalek-attack.pgm
-rwxrwxrwx 1 nick nick 353832 Feb 5 18:59 pp_warportrait.jpg
-rw-rw-rw- 1 nick nick 3630437 Feb 5 18:59 pp_warportrait.pgm
-rwxrwxrwx 1 nick nick 233724 Feb 5 18:59 squirrel.jpg
-rw-rw-rw- 1 nick nick 786448 Feb 5 18:59 squirrel.pgm
nick@NICK-PC:~/Pictures$ id
uid=1000(nick) gid=1000(nick) groups=1000(nick),4(adm),20(dialout),24(cdrom),25(floppy),27(sudo),29(audio),30(dip),44(video),46(plugdev),108(lxd),114(netdev)
nick@NICK-PC:~/Pictures$

Type `id` and press Enter to see what users and groups have been set up on your system.


Activities
Terminal
nick@nick-VirtualBox: ~
File Edit View Search Terminal Help
nick@nick-VirtualBox:~$ sudo lshw -short
[sudo] password for nick:
H/W path Device Class Description
system VirtualBox
/0 bus VirtualBox
/0/0 memory 128KiB BIOS
/0/1 memory 7976MiB System memory
/0/2 processor AMD Ryzen 7 2700 Eight-Core Processor
/0/100 bridge 440FX - 82441FX PMC [Natoma]
/0/100/1 bridge 82371SB PIIX3 ISA [Natoma/Triton II]
/0/100/1.1 storage 82371AB/EB/MB PIIX4 IDE
/0/100/2 display SVGA II Adapter
/0/100/3 enp0s3 network 82540EM Gigabit Ethernet Controller
/0/100/4 generic VirtualBox Guest Service
/0/100/5 multimedia 82801AA AC'97 Audio Controller
/0/100/6 bus KeyLargo/Intrepid USB
/0/100/6/1 usb2 bus OHCI PCI host controller
/0/100/6/1/1 input USB Tablet
/0/100/7 bridge 82371AB/EB/MB PIIX4 ACPI
/0/100/b bus 82801FB/FBM/FR/FW/FRW (ICH6 Family) USB2 EHCI Controller
/0/100/b/1 usb1 bus EHCI Host Controller
/0/100/d storage 82801HM/HEM (ICH8M/ICH8M-E) SATA Controller [AHCI mode]
/0/3 scsi1 storage

Use the `-short` flag to get a handy summary of your hardware from the command line.

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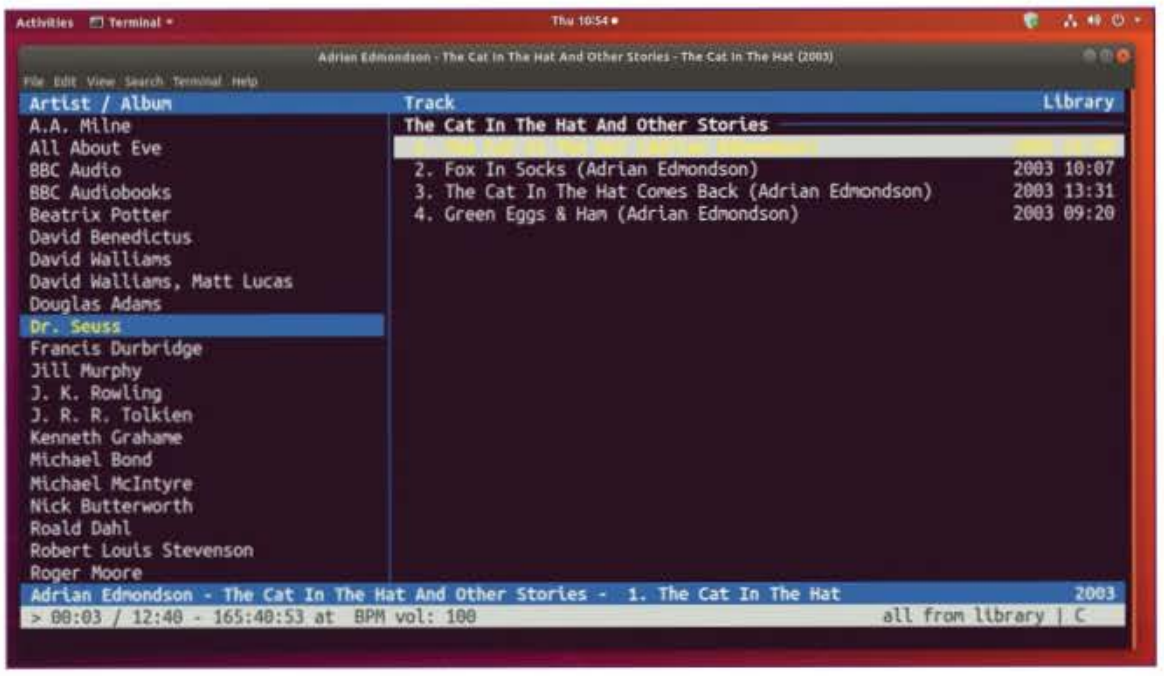
	OPERATOR				
Description	;	&&	||	|	&
Will second command execute if first command executed successfully?	✓	✓	×	✓	✓
Will second command execute if first command failed?	✓	×	✓	✓	✓
Will the second command only execute depending on the status of the first command?	×	✓	✓	×	×
Will commands execute in parallel?	×	×	×	×	✓

Chain operators enable you to link multiple commands together—here's how they work.


Activities
Terminal
Thu 10:54
Adrian Edmondson - The Cat In The Hat And Other Stories - The Cat In The Hat (2003)
File Edit View Search Terminal Help
Artist / Album
Track
Library
A.A. Milne
All About Eve
BBC Audio
BBC Audiobooks
Beatrix Potter
David Benedictus
David Walliams
David Walliams, Matt Lucas
Douglas Adams
Dr. Seuss
Francis Durbridge
Jill Murphy
J. K. Rowling
J. R. R. Tolkien
Kenneth Grahame
Michael Bond
Michael McIntyre
Nick Butterworth
Roald Dahl
Robert Louis Stevenson
Roger Moore
The Cat In The Hat And Other Stories
2. Fox In Socks (Adrian Edmondson) 2003 10:07
3. The Cat In The Hat Comes Back (Adrian Edmondson) 2003 13:31
4. Green Eggs & Ham (Adrian Edmondson) 2003 09:20
Adrian Edmondson - The Cat In The Hat And Other Stories - 1. The Cat In The Hat 2003
> 00:03 / 12:40 - 165:40:53 at BPM vol: 100
all from library | C

Cmus is an interactive music and audio player designed for the Bash shell.

is `lsmod`, which displays a comprehensive list of all modules that are currently in use. The "Used by" column lists which hardware devices each module is linked to—multiple entries are common because some drivers come in multiple parts (your graphics card requires drivers for the kernel and X server, for example).

Armed with a combination of `lspci -v` and `lsmod`, you can identify which module is being used by a specific hardware device. Once you have the module name, type the following to learn more about it:

```
$ modinfo <module>
```

Replace `<module>` with the name listed under `lsmod` (or `kernel driver in use` if you're using `lspci`). This then displays information about the driver filename, its version, and license. Other useful fields include author and description, plus vermagic.

In most cases, these modules are provided by the kernel, so vermagic should match the kernel version. One likely exception to this rule is your graphics card drivers if you've installed proprietary ones.

If `modinfo` returns an "Error not found" message, it means the listed module is an alias—to find the correct module name, type `sudo modprobe --resolve-alias <module>`, and then use the result with `modinfo`, which should now work correctly.

Chain of Command

Phew, let's move on to something less "heavy": command chaining. This is where multiple Linux commands are combined into a single line. The obvious use for a chain is to run multiple commands one after the other, enabling you to leave a lengthy process to its own devices without having to intervene. For example, quickly check for updates and install them using the following chained command:

```
$ sudo apt-get update && sudo apt-get upgrade
```

The `&&` that separates the commands is an operator, and Linux provides you

FUN AND GAMES

The command line doesn't have to be a dull place to visit. If you fancy indulging in a little fun, try these entertaining tools and tips.

First, fancy viewing any photograph or image in ASCII art? Type `sudo apt-get install imagemagick aview`, and then type the following to view it in ASCII-rendered glory:

```
$ asciiview Path/filename.png
```

If you receive an "invalid magic-not" error, you need to convert the file first, as follows:

```
$ convert filename.png filename.pgm
```

How about producing text-based banners? Use FIGlet (`sudo apt-get install figlet`), which can be as simple as:

```
$ figlet Maximum PC rocks!
```

FIGlet can also write banners using different styles—first, discover what options are supported with the `showfigfonts` command, then you can use one of them like so:

```
$ figlet -f smslant I love Linux!
```

Other flags worth noting include `-t`, which forces FIGlet to use the whole of the Terminal window's width (use `-w 70` to specify a particular column width instead), and `-p` or `-n`, which you can use when piping lots of text (say the contents of a text file) through FIGlet. Basically choose `-p` to put FIGlet into paragraph mode, where it eliminates line breaks within paragraphs.

Fancy watching a silent—but subtitled—ASCII rendition of *Star Wars?* It's available online and can be watched by typing in the following:

```
telnet towel.blinkenlights.nl
```

Finally, the Terminal's calendar command can be used to look at more than just basic calendars—for example, `calendar -f /usr/share/calendar/calendar.computer -A 365` lists some handy historical computing dates. Substitute `computer` with `lotr` (Lord of the Rings), `pagan`, `history`, and `music` for alternate calendars, or type `ls /usr/share/calendar/` to see a complete list of what's available.

TIME-SAVING TIPS & TRICKS

It doesn't matter how fleet of hand your typing skills are, the command line can still be a time-consuming, frustrating experience. Thankfully, the Terminal comes equipped with lots of handy time-saving shortcuts.

Here's how to easily access previously used commands and view suggestions:

Up/down arrows ..... **Browse command history.**

`history` ..... **View command history.**

Ctrl-R ..... **Search command history. Type letters to narrow down your search, with the most recent match displayed. Keep pressing Ctrl-R to view other matches.**

Tab ..... **View suggestions or auto-complete word or path if only one suggestion exists. Press ~ and Tab to autofill your username, @ and Tab to autofill your host name, and $ and Tab to autofill a variable.**

The following keys help you navigate the Terminal itself more efficiently:

Home/End ..... **Press these to jump to the beginning or end of the current line.**

Ctrl-left/right cursor ..... **Move quickly between arguments.**

Ctrl-U ..... **Clear the entire line to start again.**

Ctrl-K ..... **Delete everything from the cursor's position onward.**

Ctrl-W ..... **Delete the word before the cursor.**

- **Accidentally omitted `sudo` from your command? Just type `sudo !!` and hit Enter to repeat the last command with `sudo` applied to it.**
- **If you make a typo when entering a command, instead of retyping the entire command, just use the following syntax to correct the mistyped word (in the following example, `dpkg` was originally mistyped as `dkpg`): `^dkpg^dpkg`**

```
nick@nick-VirtualBox:~$ history
    1  cd Downloads
    2  sudo apt-get install ./nordvpn-release_1.0.0_all.deb
    3  sudo dpkg --configure -a
    4  sudo apt-get install ./nordvpn-release_1.0.0_all.deb
    5  sudo apt-get update
    6  sudo apt-get install nordvpn
    7  sudo apt-get update
    8  sudo apt-get install network-manager-openvpn-gnome
    9  sudo apt-get upgrade
   10  sudo apt-get install network-manager-openvpn-gnome
   11  sudo apt-get install openvpn
   12  cd /etc/openvpn
   13  sudo wget https://downloads.nordcdn.com/configs/archives/servers/ovpn.zip
   14  sudo apt-get install unzip
   15  sudo unzip ovpn.zip
   16  sudo rm ovpn.zip
   17  sudo add-apt-repository ppa:mdoyen/homebank
   18  sudo apt-get update
   19  sudo apt-get install homebank
   20  sudo apt-get update
   21  sudo apt-get install curl
```

Take a trip back in time with the `history` command.

with a choice of operators, enabling you to control how each command in the chain behaves based on the previous command. Think of `&&` as an AND operator—the second command only occurs if the first is successful (another example, `ping -c1 192.168.0.3 && ssh user@192.168.0.3`, only attempts to SSH into a computer after it's been successfully pinged).

Other operators include the semi-colon (`;`), which applies the second command after the first, regardless of whether it succeeds, and the double pipe (`||`), which acts as an OR operator, so only performs the second command if the first one fails.

You can combine multiple commands via different combinations of operators. For example, placing `&&` and `||` together is like producing an IF... ELSE... statement:

```
$ apt-get update && sudo apt-get upgrade || echo Oops, you forgot sudo!
```

Should you need to produce more complex combinations, use the command combination operator. This allows you to group related commands with each other inside `{}` characters, effectively treating them as their own separate command within the context of other commands.

The following example first checks for the existence of a file called linux.txt. If it exists, the first `echo` command is processed; if not, the commands inside the `{}` operators are executed one after the other instead:

```
$ test -f ~/Documents/linux.txt && echo linux.txt exists! || { echo linux.txt doesn't exist – creating now.; touch ~/Documents/linux.txt; }
```

Syntax is crucial—don't forget to leave a space between `{` and the command. Also make sure you include a trailing `;` at the end of the command to return to the shell after the final command is executed.

All About Pipes

Pipes are special operators designed to redirect the output of one program into another command for further processing, typically to produce a different form of output. Pipes are formed using the `|` character, which is found by holding Shift as you press the backslash (`\`) key on most keyboards. The following example pipes the result of the `ls` directory listing command to the `less` command to produce a more screen-friendly format:

```
$ ls -l | less
```

Here's a clever use of the `wc` (word count) command and `-l` flag (list the number of lines) to list the number of objects in the listed directory:

```
$ ls Documents | wc -l
```

Pipes aren't simply used to display the output from one program in another—the following example allows you to download a video from YouTube (`sudo apt install youtube-dl` followed by `sudo pip install --upgrade youtube_dl`) and then run it through ffmpeg (`sudo apt install ffmpeg`) to produce an audio-only MP3 file:

```
$ URL=https://www.youtube.com/watch?v=QvKBeOKvblI
$ youtube-dl $URL -q -o - | ffmpeg -i - audio.mp3
```

Finally, you can combine multiple piped outputs in the same way you can build complex chains using other operators:

```
$ youtube-dl $URL -q -o - | ffmpeg -i - audio.mp3 && play audio.mp3
```

Play Music in Linux

The `play` command is part of the SoX tool, which you obviously need to install to play your converted music file. Install it with `sudo apt install sox libsox-fmt-all`. The `libsox-fmt-all` library includes support for proprietary formats, such as MP3.

Once installed, you can also use SoX in jukebox fashion by navigating to a folder

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Viewing[SSL] <Maximum PC>

The w3m browser is a text-only affair in the Terminal or Windows Linux subsystem...

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2/6 images loaded

...but does display images when you're running it from the Linux shell.

containing some music and issuing the following command: `play *.mp3`. Press Ctrl-C to jump to the next track, or press it twice to stop playback. Type `play --help` to see a full list of options, including a wide range of effects and filters, such as:

```
$ play *.flac bass +2 gain +1 reverb
```

If you'd like a more interactive player, try `cmus` (`sudo apt install cmus`). Once launched, after a short pause you'll be shown a two-pane window. The app is controlled in a similar way to the Vi text editor—for example, to load your "Music" folder into the program:

```
:add ~/Music
```

You can then browse for tracks and playlists, and type `man cmus` for a detailed user guide. You can also plug in extra features via extension scripts—see https://github.com/cmus/cmus/wiki for more details.

Access Internet Resources

The Internet is fully accessible from within the shell. Let's start things off with web browsing. The w3m-img browser can display web images from inside the shell (within a regular Terminal window or the Windows Linux subsystem, it only displays text). Install it with `sudo apt-get install w3m-img`. Once done, launch it thus:

```
$ w3m www.maximumpc.com
```

Use the cursor (or mouse) to navigate around the page, hit Enter to visit hyperlinks and—if supported—you'll see images rendered inline as you scroll, while text is color-coded to aid navigation. Press q to quit—a full list of commands can be gleaned by pressing H.

Here's a neat little trick: looking for a weather forecast? Simply type `curl http://wttr.in/~your_city` and hit Enter for a three-day forecast, covering morning, noon, evening, and night. You'll need to resize your Terminal window for the full effect, though.

The shell is also a great place to download files—check out the box on the right for a range of tools for doing so.

DOWNLOAD FILES FROM THE SHELL

How about downloading files from various online resources? The `wget` tool is your friend, capable of pulling content from HTTP, HTTPS, and FTP servers, like so:

```
$ wget "http://url.com/file.zip"
```

Add the `-O` flag if you would like to save to a different directory (`wget -O /home/username/Desktop/ http://url.com/file.tar`). As the file downloads, `wget` provides you with a progress bar, but if you're downloading a particularly large file, press Ctrl-C to cancel the current download, then use the `-b` flag to download in the background:

```
$ wget -b -O /home/username/
Downloads/ http://url.com/
download.iso
```

Type `ls -l -block-size=M` and hit Enter periodically to see how far the download has got by reviewing its file size.

A better tool for accessing FTP servers is the interactive ftp tool: type `ftp` and press Enter to get started. The cursor changes to "ftp>" so type the following to connect to a remote server:

```
ftp> open ftp.example.com
```

You're prompted to enter a username and password if required, and then you're in. Use the same tools you use to navigate your filesystem: `cd` for changing directories, `ls` to list directory contents, and so on.

Type `get filename` to download a file to the directory you were in when you invoked `ftp`, or `put filename` to upload it from the same directory.

Need to grab a file using BitTorrent? Start by installing rTorrent (`sudo apt install rtorrent`). Next, type `rtorrent`, and then press Enter twice to reveal the "load.normal>" line. Simply type or paste your torrent URL here and press Enter to load it. Now use the cursor keys to select the torrent file from the list, and press Ctrl-S to start the download. You can stop the download at any time using Ctrl-D, or quit rTorrent completely using Ctrl-Q.

TECH PORN

PERFORMANCE GEAR LAID BARE

Asus ZenBook Duo

INNOVATION IS VITAL within the tech industry; many products live or die based on their USPs or next-gen features, and hardware that fails to innovate frequently fails to excite, too. Asus wants to grab the innovation points with this laptop, the Duo edition of its ZenBook line. Calling it a dual-screen laptop isn't fully accurate; it's more like a regular laptop with a super-powered touchbar, giving you instant fingertip control.

Asus has given it a funky name, of course: the ScreenPad Plus. It does act as an extension of the upper screen, so you can pull open tabs down to the second display, but it also rocks a custom UI for quick access to useful programs. The keyboard is at the base of the chassis, and makes for a very comfortable typing experience, while the trackpad is squeezed to one side.

Internally, a 10th-gen Intel CPU and discrete graphics card (Nvidia's MX250) mean that the Duo can handle whatever work you throw at it, and it comes with up to 16GB of RAM and a high-speed 1TB SSD. There's the usual suite of modern laptop additions here, too, from a Windows-Hello-enabled IR camera setup to Harman Kardon certified audio that results in impressive sound for such a small laptop. The built-in Cortana and Alexa support work fantastically, too. –**CHRISTIAN GUYTON**

1 STAY CONNECTED

Connectivity is definitely the ZenBook Duo's strong point, because every model comes equipped with superfast Wi-Fi 6 and Bluetooth 5. Physical connectivity is just as good as wireless; two USB-A ports and a USB-C port are joined by an HDMI connector for attaching a second (third?) monitor.

2 CLEAR COLOR

The LED-backlit display is a fairly standard 1080p panel, but the 100 percent sRGB means colors are vibrant. With a slender bezel, the screen looks great, and wideview tech brings a 178-degree viewing angle to the main display and the ScreenPad Plus.

3 TOUCH AND GO

The ScreenPad Plus comes with a set of apps designed to be used on the slender lower screen, all accessible with a few quick taps. Most useful is a numpad app, as the Duo lacks a physical numpad, but we also like the Spotify app, perfect for keeping control of your tunes while you work on the top screen.

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HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

TIP OF THE MONTH

TAKE OFF YOUR SOCKS!

Feels like a strange one, doesn't it? But if you build PCs at home, chances are you don't do so wearing shoes. But barefoot is a better option than wearing socks, because it helps to reduce the build-up of static electricity. There are more elegant solutions (such as antistatic floor mats), but taking your socks off is easier, and also costs nothing!

CHRISTIAN GUYTON
STAFF WRITER

INTRUDER WINDOWS

This month, I've been wading knee-deep through the thick sauce of Windows 10 optimization, casting my net to and fro to gather handy tips even as my galoshes slowly fill with bloatware.

I love Windows 10, I really do; not since Win XP have I been able to say I genuinely like using the OS on my home PC. It has a lot of great features that I probably take for granted, from Windows Defender to defragging tools.

Yet sometimes I yearn for the simplicity of older operating systems. Windows Vista never tried to make me play *Candy Crush Saga;* XP didn't come loaded with software designed to soak up user telemetry.

Of course, Microsoft is far from the only company guilty of this. So many tech companies seem overly eager to shove their software on to our desktops; most are innocent, just trying to gather information to improve the service, but they're just unnecessary.

It's a hassle; like ads for the product I already purchased. I'm afraid of *Ready Player One's* antagonist manifesting in the body of a real-life marketing director, informing his boardroom that "we can sell up to 80 percent of a user's visual field" for ad space. I can only hope manufacturers choose to go down a better path.

MAKE – USE – CREATE

54
Catalog your collections with Data Crow

58
Back up your data safely with File History

68
Put together a party PC you can take to a pal's place

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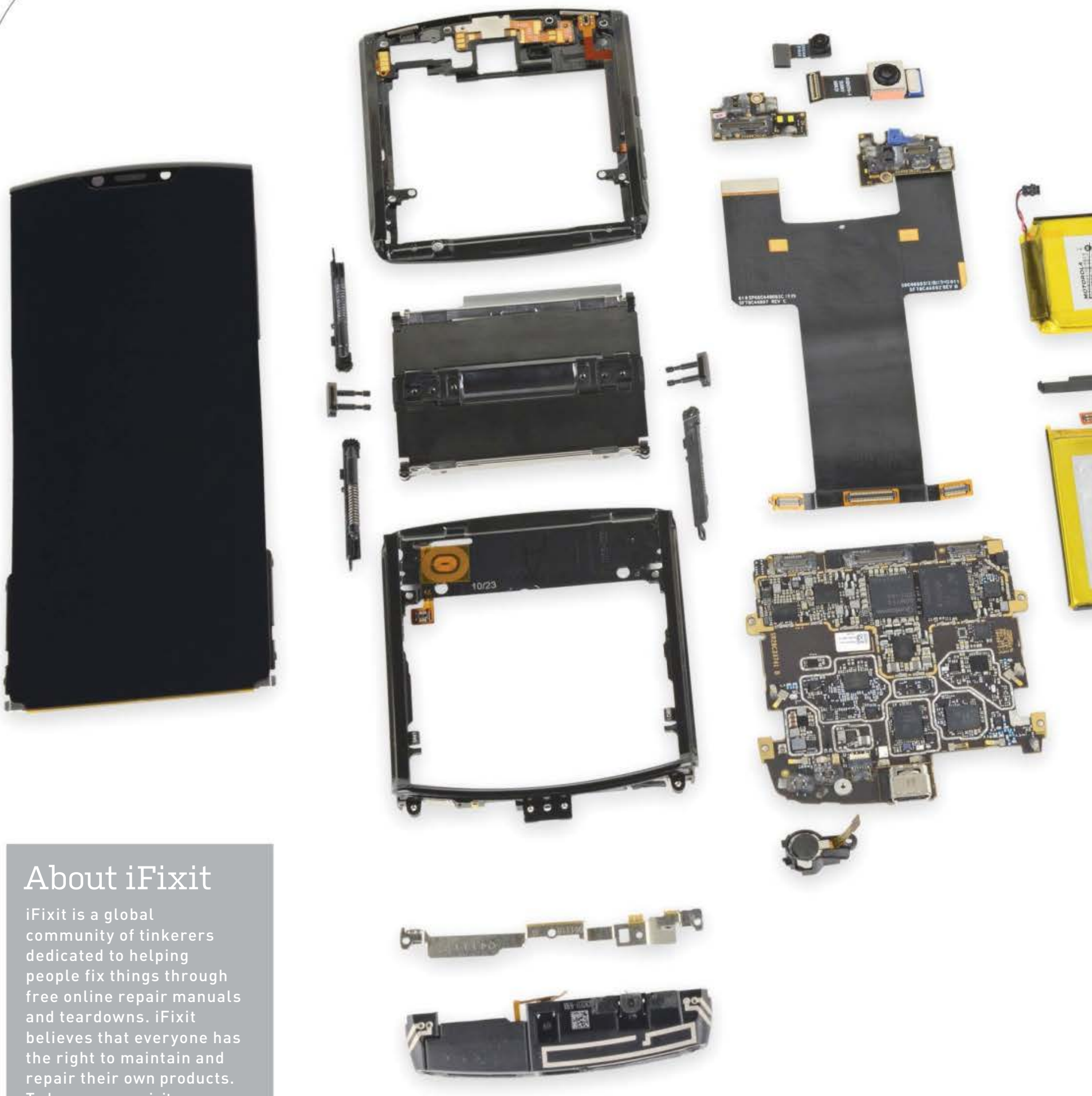
↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...



About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

This month, we're taking a knife to Motorola's new Razr.

Motorola Razr

The main folding mechanism is an impressive feat of engineering.

Prepare yourself for some sticky gunk when pulling apart the latest phone.

BACKGROUND

If you're still rocking that iconic Razr flip-phone from 2004, we have good news: those "podcast" things really took off, *The Incredibles* finally got a sequel, and there's a new Razr that'll blow your mind. Let's test its teardown-ability.

MAJOR TECH SPECS

- 6.2-inch 2142x876 foldable plastic OLED display (~373 ppi)
- 2.2GHz octa-core Qualcomm Snapdragon 710 processor
- 6GB of RAM, 128GB of storage, 2,510mAh of battery power
- 16MP f/1.7 main camera with dual-pixel autofocus and one 5MP f/2.0 selfie camera

KEY FINDINGS

- Back in our day, the Motorola Razr was the coolest thing around. We're happy to see that the new Razr keeps the sleek look. All the modern-day gear adds bulk, though. The new Razr is 35 percent wider and 118 percent heavier than our 2004 V3, so it's less pocketable than you'd think.
- Our first target is the lower rear cover. Behind the fancy folding façade, this is still a smartphone like any other, so we're guessing a hot iOpener is our ticket in. A little heat does the trick! Once all the glue is sliced, the cover can wiggle free. But the fingerprint sensor cable, next to the home button, is waiting to be torn by eager disassemblers.
- Battery ho! But no other fun goodies, so we opt to pop the Quick View display off the other side. Despite some nasty glue, it eventually comes free, and we catch our first glimpse of the second battery. The first battery's ready for removal in the bottom half of the phone, but the second is still hiding behind some cables in the top half. Above the batteries, the single 16MP main camera stares back at us.
- As we hone in on the flexible display, we hope we don't mess it up, but for now, we're breezily unscrewing Torx screws with our handy Mako kit. With a bit of alcoholic coercion, the first battery comes free. One brief pit stop on our race to mobo glory: In removing the vibration motor (a boring coin-style one), we spot some curious slime.
- Flipping this floppy foldable is a lot easier after a few more screws, and gives us access to the cameras and second battery. With the pOLED display removed, we're dismayed that the battery comes with it. Prying against this flexible sheet for a battery swap doesn't seem ideal, even if the battery is in a metal caddy. We finally have both batteries; the second packs more punch, at 1,265mAh and 4.8Wh, than the wafer-thin 4.7Wh cell we extracted earlier.
- Motorola's nostalgia-stoking Razr wins the award for most complicated phone-based contraption we've ever taken apart. We're impressed with the numerous feats of engineering that Moto pulled off to resurrect its iconic clamshell. It won't win any awards for serviceability, but just bringing this gizmo into existence was such a tall order that we're not surprised serviceability didn't make it into v1.0. It's fun to see how they made it happen.
- Repairability Score: 1 out of 10 (10 is easiest to repair). The only driver you need is a standard T3 Torx. The delicate primary display is replaceable, if you're determined. Every repair starts (and ends) with stubborn, glued-on outer covers. Replacing the batteries requires near-total disassembly. The charging port is soldered directly to the main board. Complex construction and multiple flex cable booby traps make for tricky repair work.

Catalog Collections with Data Crow

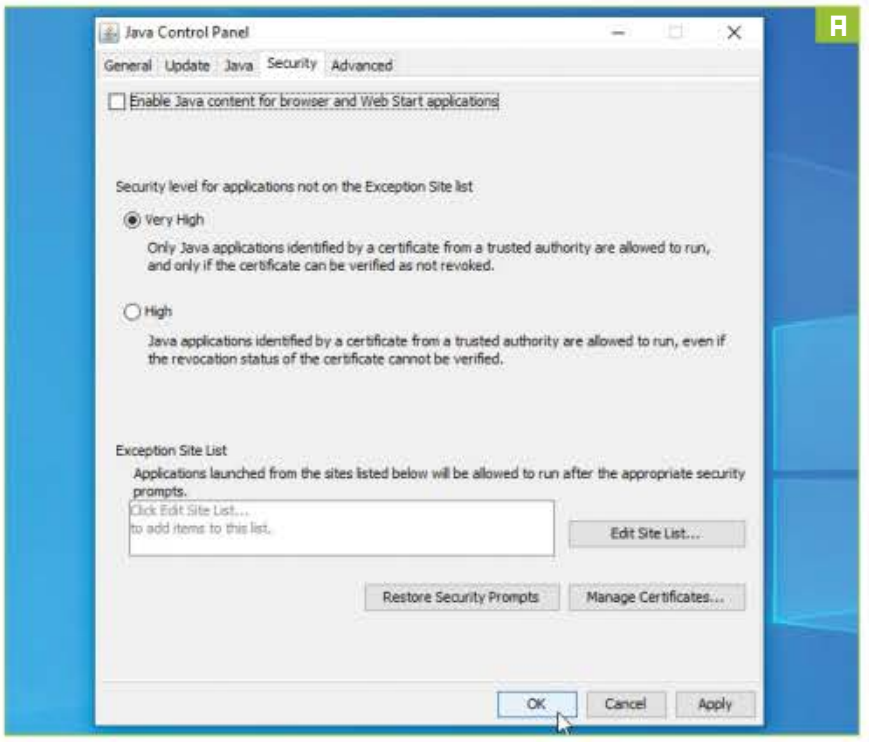
YOU'LL NEED THIS

DATA CROW STANDALONE CLIENT
Plus optional Data Crow server (available via Docker).

EVER NEEDED TO KEEP A CATALOG of important items you own? Perhaps your DVD collection needs organizing before you start lending it out to friends or family, or you want to keep tabs on your books. Maybe you'd like to make a definitive list of your music to avoid going out and accidentally buying another copy of an album you already own. Or perhaps you're looking to record a more personal treasure, from baseball cards to stamps.

Whatever your cataloging needs are, Data Crow is the tool for you. This underrated freebie makes it easy to start building and managing collections of all sizes, and thanks to some nifty time-saving tools, you don't necessary have to meticulously record everything yourself. Instead, Data Crow has linked in with several online providers to make it possible to automatically populate the information you need from various web-based services (sadly, not all currently work, due to changed API settings on the part of Amazon and iMDB).

Read on to learn how to collate your collection, access it from any computer on your network, and set up a loan-administration system so you know who's borrowed what. **–NICK PEERS**


A
Java Control Panel
General
Update
Java
Security
Advanced
Enable Java content for browser and Web Start applications
Security level for applications not on the Exception Site list
Very High
Only Java applications identified by a certificate from a trusted authority are allowed to run, and only if the certificate can be verified as not revoked.
High
Java applications identified by a certificate from a trusted authority are allowed to run, even if the revocation status of the certificate cannot be verified.
Exception Site List
Applications launched from the sites listed below will be allowed to run after the appropriate security prompts.
Click Edit Site List...
to add items to this list.
Edit Site List...
Restore Security Prompts
Manage Certificates...
OK
Cancel
Apply

1 CLIENT-ONLY INSTALLATION

Data Crow comes in both standalone and server-client configurations—whichever option you choose requires the Java Runtime Environment (on the upside, this means you can run Data Crow on Windows, Mac, and Linux). If it's not already installed, go to http://java.com and click "Java Download." If you're happy running the 32-bit version of Data Crow (most are), just click "Agree and Start Free Download," otherwise click "See all Java downloads" to choose the "Windows Offline (64-bit)" installer instead. Save the installer to your "Downloads" folder, then double-click it, and click "Install" when the Java setup appears. Click "Close" when complete.

›› Once installed, type "java" into the "Search" box, then click "Configure Java." Switch to the "Security" tab—if you only plan to use Java with Data Crow, uncheck "Enable Java content for browser and Web Start applications." Select "Very High" for the security level, then click "OK" [**Image A**].

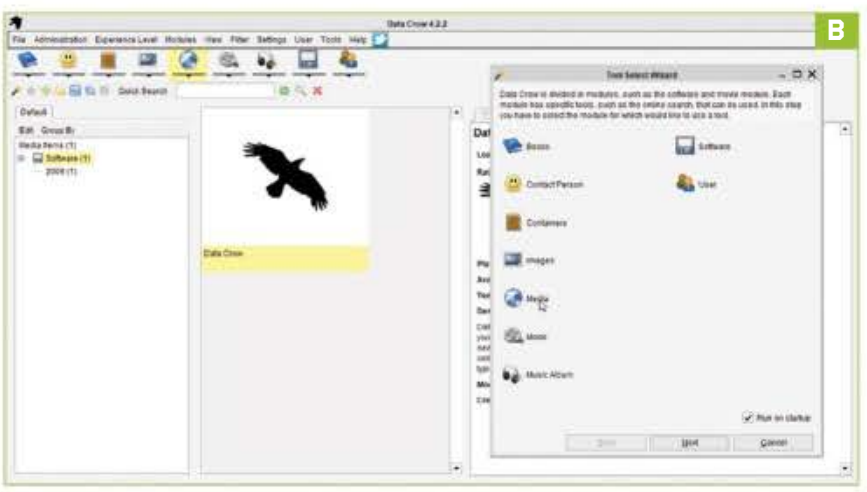
›› The box on page 57 reveals how to get started with a server-client configuration for multi-device access. For standalone configuration (or to install the client on your PC), head over to www.datacrow.net, select "Downloads" from the left-hand pane, and click "Data Crow Windows Installer" to go to the FossHub website.

›› Here you've got a choice between "Portable (All Platforms)" for adding Data Crow to your portable toolkit, or "Windows Installer." Either way, save the zip file to your "Downloads" folder. Once done, locate the zip file, right-click it, and choose "Extract All." Then it's a case of double-clicking the correct 32-bit or 64-bit file (clearly marked) to either install the program or run the portable version. Follow the wizard to its end—the default choices are fine for most—then click "Done."

2 CREATE CATALOG

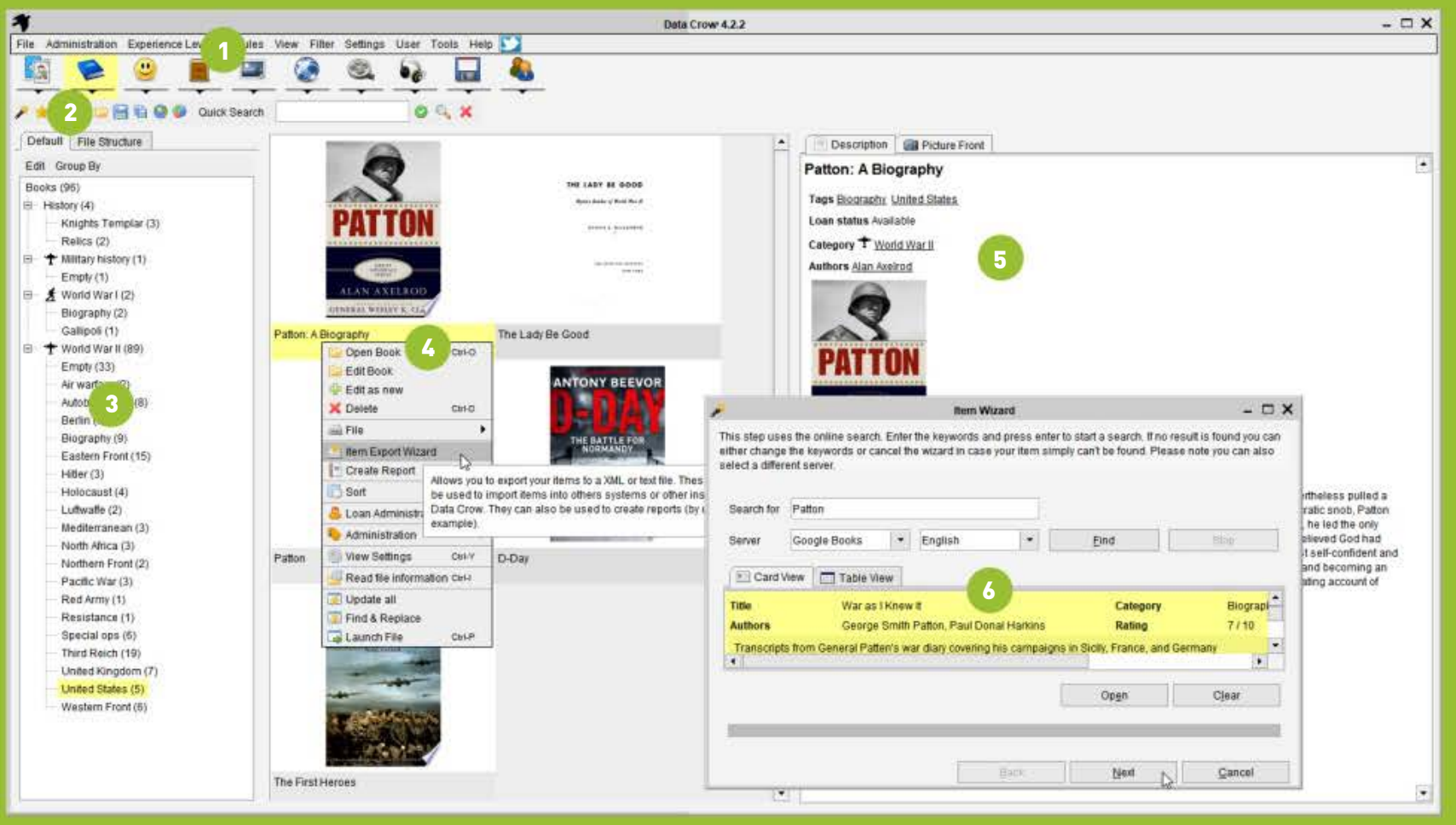
Run Data Crow. First, choose where to store the program's data, such as inside your "Documents" folder or OneDrive storage. Click "OK," select your language, and click "OK" again. When the program opens, click "Close" to open the Tool Select Wizard. Choose the type of information you'd like to catalog [**Image B**]. Data Crow stores information in modules—think of each one as a separate database, with the ability to link related databases together.

›› Data Crow specializes in media collections, with prebuilt modules for books, images, movies (including TV shows), music, and software. In addition, you'll see modules for users, contacts, and containers. Containers



© DATA CROW

EXPLORE THE DATA CROW INTERFACE



1. MODULES
Use these buttons to select a collection; contacts, books, images, movies, music, and software are included, while any custom collections appear here, too.

2. ITEM MANAGEMENT
These buttons enable you to manage your catalog by adding, deleting, and even visualizing your items. Both pie and bar charts are available, based on a selected field.

3. NAVIGATION STRUCTURE
Items are organized into a hierarchical structure—we're organizing our book collection by category, then tags. Books may appear under every tag you assign.

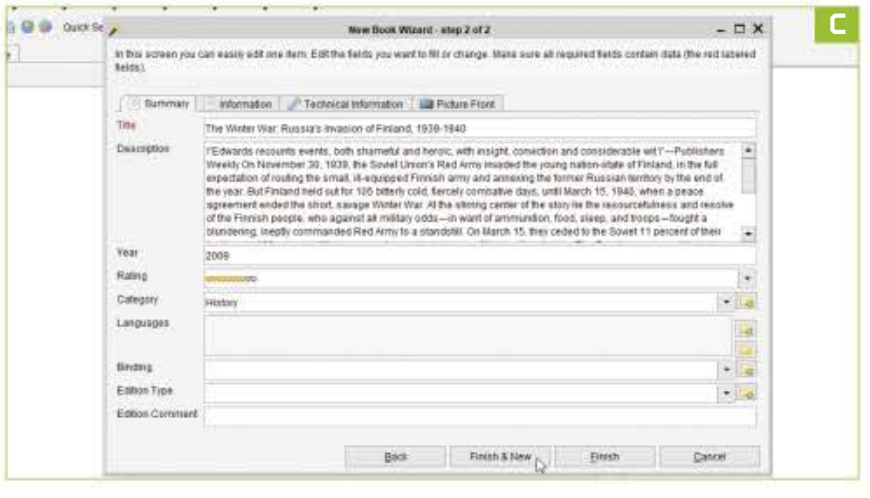
4. EDIT ITEMS
Need to make changes or add info? Navigate to the item on the left, then double-click it, or right-click for more options, such as "Edit as new" to create a new entry based on the current one.

5. ITEM DETAILS
The selected item appears on the right, complete with any information that's been assigned to it. Note: Only fields marked with "Descriptive" when defining fields are shown here.

6. ONLINE SERVICES
Add items using online services such as Google or the Movie Database, which download and automatically fill key fields, even adding artwork if available.

provide a physical repository (such as a box or filing cabinet) to store your items in, while Contacts allows you to build up a list of people to whom you lend items. The Users module enables you to set up multi-user access—see the box (pg. 56).

» You'll also see a Media module—this provides a single interface for viewing all your collections. There's also a "hidden" Property module type, which can be used to simplify data entry in other modules. If your collection isn't covered by any of the pre-built modules, you can build your own in step 6.



3 ENTER ITEMS VIA WIZARD

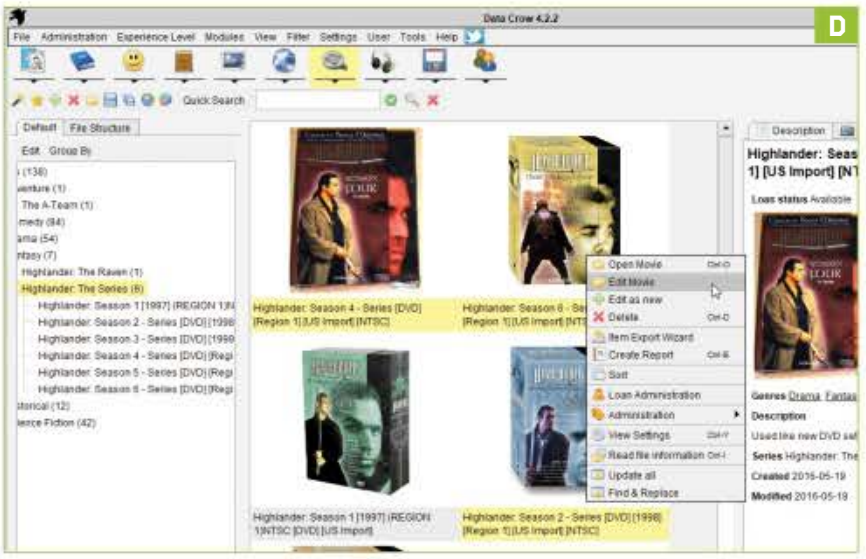
There are two ways to enter information: a simple wizard-based approach, and the manual approach. Click "Item Wizard" to get started by adding an item from an online database. If you're in the Media section, you're prompted for the item type, otherwise you jump straight to the search tool. Remember, Amazon servers are off limits, so the Software search is useless because no other online databases are provided (instead, skip to the next step to input information manually).

» Next, select your online database, then enter the name of your item, such as a book's author or title, and click "Find." A list of matching results appears. Switch to the "Table View" tab for an easier way to review them. If there are multiple matches, select one and click "Open" to check it's the correct match using the tabs—"Picture Front" often helps [**Image C**]. Once you've found the right match, click "Next." The information is downloaded,

MULTI-USER ACCESS

Data Crow supports multiple users, enabling you to grant others varying levels of access to your collections, from read-only to full editing capabilities. Click the "User" icon followed by the green "+" button to set up a user. Fill in the details on the "Summary and Information" tab—key fields include "Name" and "Login Name," and don't forget to check "Enabled" so the user is active. Control access via the "Module Permissions" tab—this gives you control over their access on a module-by-module basis. By default, users have view-only access to all your modules, but click "Edit" to deny all access or extend full editing rights to that module.

After clicking "Save," the user is able to log in with their username and a blank password—to assign a password to their account, right-click their entry, and choose "Change password." While you're here, be sure to assign the main administrator user a password, too, via "User → Change Password," unless you're running Data Crow as a server-client setup using a Docker image, rather than the standalone packages. Check out the "Server Install" box for more details of setting this up.



D

allowing you to review the entry, plus make further edits or additions. To keep your items organized, look for suitable fields on the "Summary" and "Information" tabs, such as "Category" or "Genre." Click the "+" button to add additional entries if they don't cover your collection (books are poorly represented, for example). Once done, click "Finish & New" to add another.

4 ENTER INFO MANUALLY

To enter an item's information yourself, click the green "+" button. You'll see a multi-tabbed window with a series of fields to fill in, geared toward the type of information you're cataloging. Some of these fields require typing into, others have drop-down menus from which you can pick a choice, such as rating or category. These link to category modules (more on this shortly)—look for the new folder button next to these, where you can create your own custom entries if none of the ones provided matches what you're looking for.

›› How much information you supply is up to you—most fields should be self-explanatory, and only those fields marked in red are compulsory; everything else can be left blank or filled in later (see the next step). If it's present, use the "Update" button to try your luck with any supported online search providers.

›› The "Picture Front" tab provides the ability to import a cover image one of three ways: from an existing file on your PC, via an online URL, or from "memory" (the clipboard). These latter two options are perfect when used in conjunction with an online image search in your browser. There are also tools on the "Edit" menu for blurring, sharpening, rotating, and converting the image to grayscale, plus deleting it (the closest thing to an undo function, assuming you're happy to then reimport the image).

5 EDIT AND ORGANIZE ITEMS

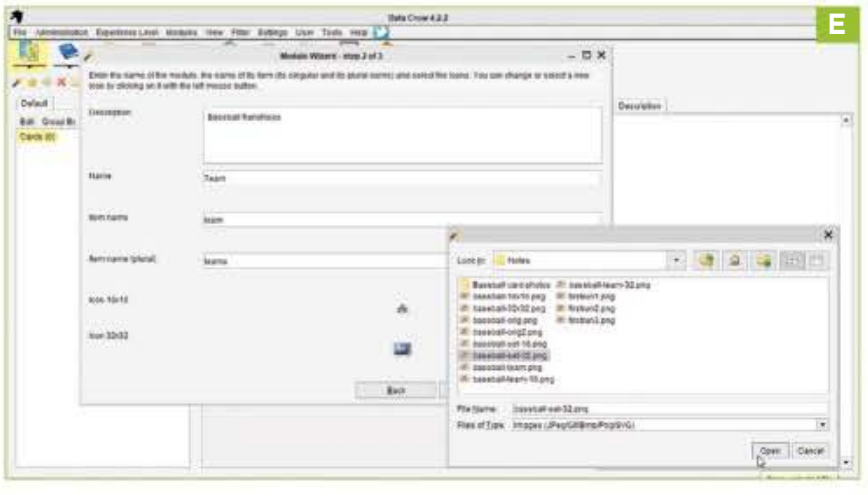
Keep adding items to your collection. If you want to edit an item, right-click it, and choose "Edit." If you want to make the same edits to multiple items, select them using the classic Ctrl-click method, before right-clicking, and choosing "Update all." Make your changes, then click either "Save" or "Apply" to apply them to the selected entry or entries in your database [**Image D**]. You can also perform "Find/Replaces" of text across your entire collection via the "Filter" menu.

›› As your collection grows, you'll need to organize it to make it easier to browse. To do this, click the "Group by" button in the left-hand window and choose "Select Fields" to choose which field to organize them by, such as author or category. To create a multi-level hierarchy, select multiple fields in the order you wish them to appear—for example, genre followed by TV series name.

›› Another way to organize items is through the Container module. Here you can define repositories—physical or virtual—inside which your items are stored. Creating a container works in a similar way as other modules, with one key addition: the "Container Type" field. You'll see several examples provided—three types of physical CD storage—but you could use it to define a location—virtual for ebooks, physical for actual items (such as a box or cabinet). Container Types can be managed from the "Administration → Maintain Container Types" menu.

6 BUILD YOUR OWN CATALOG

The "Modules" menu is where you need to go if you wish to either tweak an existing module (say to add a missing field or remove fields you don't use) or build your own collection type from scratch. Choose "Modules → Alter Module Wizard" to alter existing modules, where you open access to a load of hitherto hidden modules, relating to ancillary information such as actors, directors, or record labels. These are Property modules, used to provide the options that


E

© DATA CROW

appear on fields that allow you to select one or more entries from a list. Select one to make changes to it.

›› What about cataloging something not covered by the pre-defined modules, such as your baseball card collection? Choose "Modules → Create Module Wizard." A choice of four module types are provided, and we're using two of them. We need to create two separate Property modules, one to list available card sets you own, and the other to list baseball teams. Start with the card set: Click "Property Module" to enter a name ("Baseball card set"), optional description, plus item name in singular and plural ("card set" and "card sets"). You can assign 16x16 and 32x32 icons by clicking the existing ones and choosing your replacements [**Image E**]. Click "Next." The pre-defined fields should be adequate for your needs, so click "Finish & New."

7 SET UP MODULE FIELDS

Repeat for your baseball team module, then after clicking "Finish & New" again, choose "Other Module (no predefined fields)" to set up the main module. The process is identical to the Property module, but here you need to spend some time setting up the fields you want to record—no pre-defined ones are available . The good news is that you can always tweak the module after creating it, so perhaps now focus on the bare minimum you need to get your collection up and running.

›› Click "Add Field"—this is like setting up a regular database. Give each field a name, type, and whether it's searchable, part of the description, or a key field (only required if you plan to link in with another database). To tie into a Property module, such as your card sets or baseball teams, choose one of the "Reference Field" options ("Dropdown" for a single choice, "Multi-select" if you'll be selecting multiple entries), then choose the module you created in the previous step [**Image F**]. Click "OK."

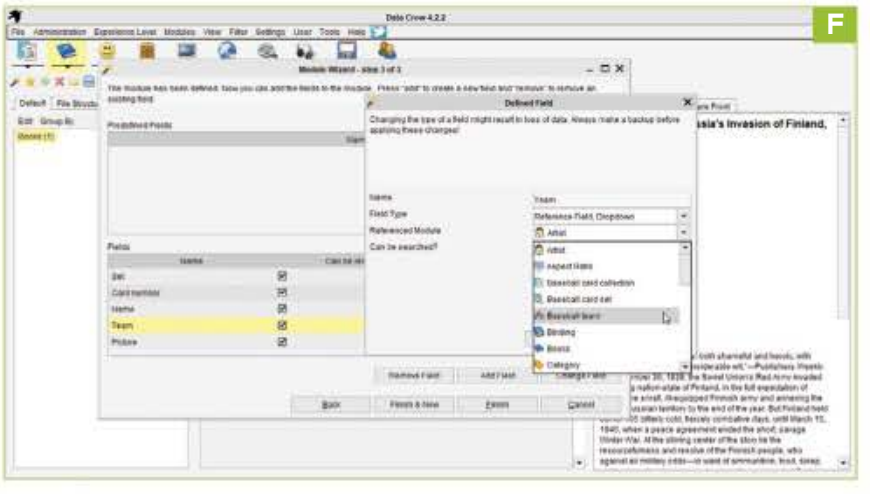
›› Repeat for any other fields and click "Finish," then "Yes." Data Crow quits, but when you restart you should see your new module's icon is now visible next to the existing modules, allowing you to focus on inputting your collection's details.

›› Select the module icon, then click the green "+" button to enter your first record, as outlined in step 4. When it comes to filling in details from the Property modules you created earlier, they start off blank—just click the "+" button next to the drop-down menu to create your first entry, then it'll be available as an option from the drop-down menu.

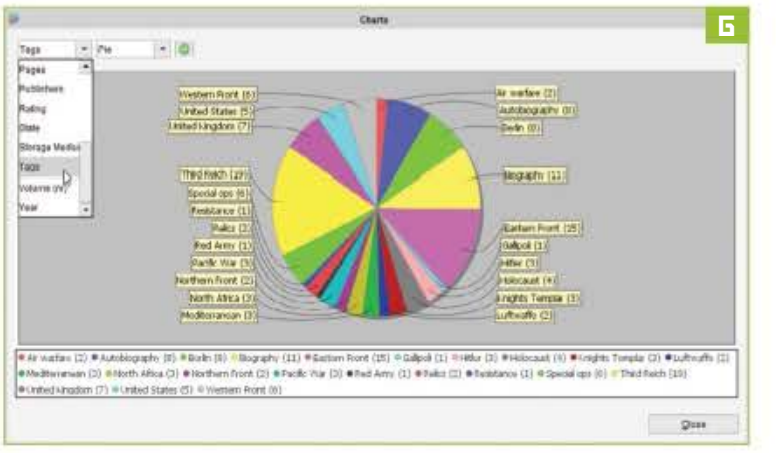
›› To speed up the creation of Property module entries, use the "Administration → Maintain <module name>" menu. You can add items singly (with icons if required), or set up a load of entries with just a title field via the "Create Multiple" button.

8 BROWSE AND VISUALIZE YOUR COLLECTIONS

You'll see how easy it is to browse your collection from the main Data Crow window, but once your collection grows beyond a certain point, you'll want to make use of other tools to help visualize your items. A Quick Search tool provides an instant filter—click the magnifying glass icon to perform a more advanced search using a combination of custom-built filters, with the ability to sort results a specific way. Use the "Maintain" tab to save—and later reapply—your carefully crafted searches.


F

›› Also explore the "Tools" menu, where you'll see an option to create reports and even pie or bar charts to help visualize data from the currently selected module—with charts, simply select your chosen field to generate the chart [**Image G**].


G

9 SET UP A LOAN SYSTEM

Finally, one of Data Crow's primary functions is to serve as a tool for administering loans of items in your collection. Use the Contacts module to build up a collection of family and friends you're going to lend items to. Select the item you plan to loan out and double-click it. Switch to the "Loan Administration" tab, where you can select start and end dates for your loan, plus select the person you're lending to. Click "Lend this Item." You can see who's previously borrowed the item from here, plus select "Administation → Loan Administration" to keep an eye on who's currently got what.

SERVER INSTALL

One way to share access with other users—or to give yourself access to your own collections from multiple devices on your network—is to install the server version of Data Crow. Like the client, it requires Java, so can run on any server that supports that. Download it from the same FossHub site (www.fosshub.com/Data-Crow.html) as the client. Full instructions can be found at http://datacrow.net/manuals/data_crow_client_server_howto.pdf should you go down this route.

A Docker version of Data Crow is also available (https://hub.docker.com/r/linhares/data-crow-server)—but be warned: This version doesn't support user credentials (so you won't be able to assign the default SA user a password without crippling the whole setup).

Once up and running, verify the server is working by opening your web browser and browsing to http://192.168.x.y:8080/datacrow, substituting "192.168.x.y" with your server's IP address and "8080" with whichever port that you assigned to it. Log in and you can perform many features through here. For complete functionality, however, use the Data Crow client: Modify the existing shortcut to append "- client" to the end of the "Target" box. Now open the shortcut and you'll see a login screen—fill in the details and click "OK" to connect.

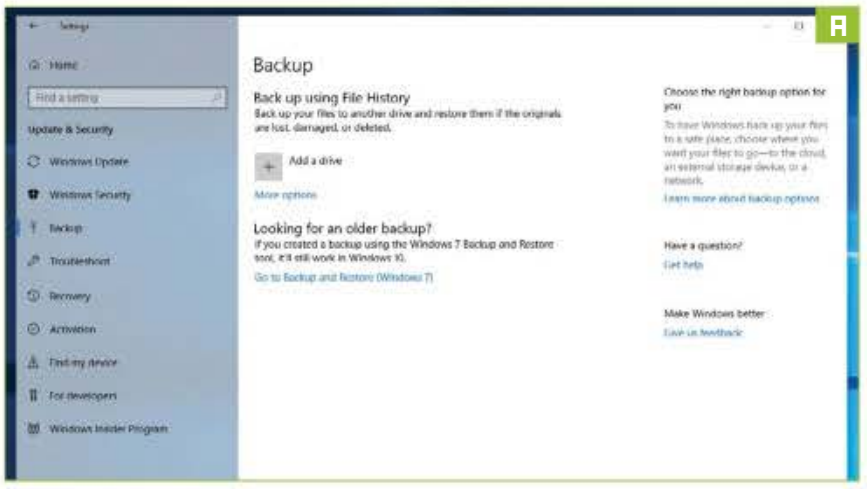
Back Up Data Safely with File History

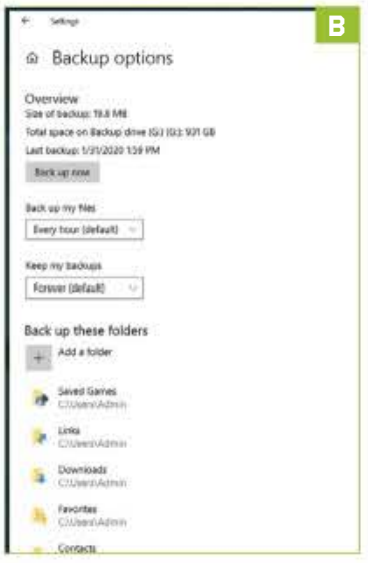
YOU'LL NEED THIS

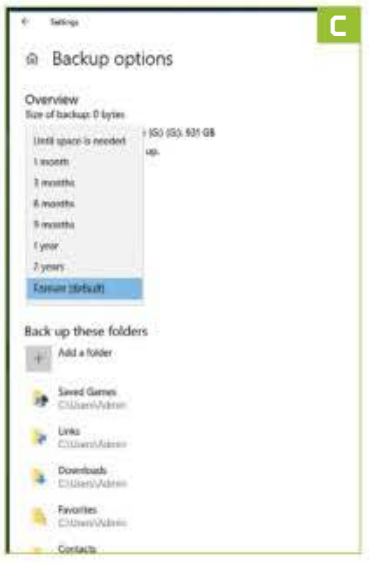
EXTERNAL HARD DRIVE
Or you can use a network drive, in which case you also need an Internet connection.

WE'VE ALL GOT THAT NAGGING VOICE in our minds telling us to back up our important data. But just like using more secure passwords to keep our accounts safe, it's something that all too often is put off for a rainy day. Luckily, backing up your files in Windows 10 is much easier than you'd think. Perhaps aware of how much passive resistance there is to backing up, Microsoft has made the whole process simple and straightforward. Once you know how to do it, there's no excuse not to protect your files from disaster.

We'll take you through the process of creating a local backup with Windows 10's built-in File History feature, which enables you to quickly restore backed-up data, too. We also recommend you consider an online backup service in addition to any local backups you make. That way, if something drastic were to happen (fire, flood, tornado, or act of God), you've still got your files safely secured off-site. With File History, you can back up selected files to your chosen drive, restore from it, or clear out older backups if you need to free up space. And if you want to restore backups created on older versions of Windows, we've got more information about that in the boxout opposite. –**ALEX BLAKE**


A
Backup
Back up using File History
Back up your files to another drive and restore them if the originals are lost, damaged, or deleted.
Add a drive
More options
Looking for an older backup?
Go to Backup and Restore (Windows 7)
Choose the right backup option for you
Have a question?
Get help
Make Windows better
Give us feedback





1 SET UP FILE HISTORY

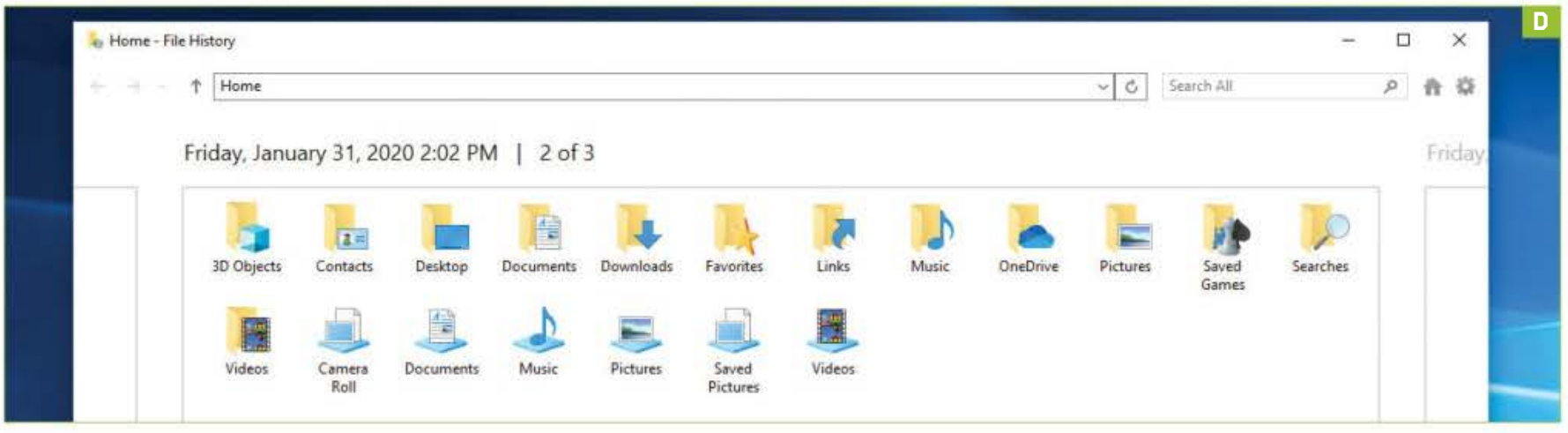
First, you need an external storage drive or network drive to serve as your backup location. We suggest you use a large, empty drive to give yourself plenty of space for backups. If you want Windows 10 to back up your files automatically, you need your PC to be connected to this drive at all times.

›› Now open the Windows 10 Start menu and click the cog icon above the "Power" button; this opens the Settings app. Click "Update & Security," then click "Backup" on the left.

›› Under the "Back up using File History" header, click "Add a drive" [**Image A**]. Windows searches for available drives that can be configured as backup locations. Once it's finished scanning, select your chosen drive. By default, Windows automatically backs up your files to this drive.

›› If you want more control, click "More options." This takes you to a screen of settings, enabling you to back up exactly what you want, when you want. If you turned off the option to have Windows automatically back up your files—or you want to back up before the scheduled time—click "Back up now" to get started immediately [**Image B**].

›› To change the backup schedule, click the drop-down menu beneath "Back up my files." This is set to



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every hour by default, but you can choose options from every 10 minutes to once per day. Below this option, you can tell Windows how long to keep each backup. The default is forever, but you can pick a minimum of one month if you like, or "until space is needed" for a more dynamic option [**Image C**].

›› File History automatically selects key folders from within your My Documents folder, including Pictures, Downloads, Music, and more. It also includes files from your C:/Users home folder. If you have multiple drives connected, it includes these folders on each drive they appear on.

›› To remove a folder, click it, then click "Remove." Click "Add a folder" in the "Back up these folders" section to put additional folders on the backup list. And if there's a folder you want to exclude, choose "Add a folder" beneath "Exclude these folders."

›› If you've run out of space on your backup drive (or just want to start backing up to a different drive), click "Stop using drive" at the bottom of the window. This doesn't delete any of your current backups, so they're still safe. Now hook up the new drive to your PC and repeat the process of adding it to File History.

2 RECOVER ITEMS

To recover from a backup, open the Settings app and navigate to the "Backup" section. Click "More options," then click "Restore files from a current backup." This opens a new window that lists all available backups [**Image D**]. You can move between backups by clicking the arrow buttons.

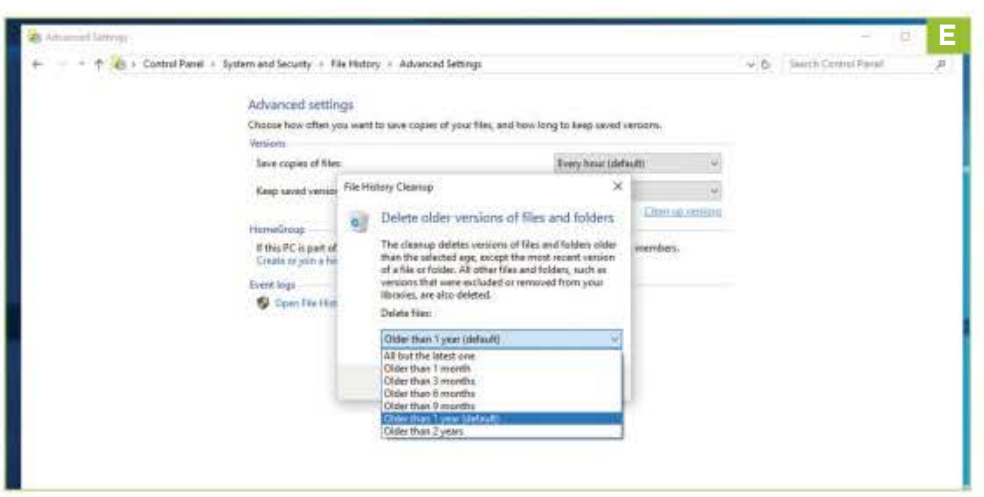
›› Once you've chosen an appropriate backup, you can browse through the files and folders it contains. Select one or more items to restore, then click the green button at the bottom of the window. If the file or folder has the same name as an item in its targeted location, Windows warns you of the file conflict. You can opt to replace the newer item with the backed-up version, skip the file you're trying to restore, or keep both.

›› You can also restore older versions of files from within Windows Explorer. Find the file in question, then right-click it, and select "Restore previous versions." If you've previously backed up the file using File History, its older versions are displayed in the resulting window. Just click the version you want to bring back, then click "Restore." If you'd rather restore it but save it in a different location from the current file, click the down arrow next to "Restore," then click "Restore To."

›› On the other hand, you can navigate to a folder (or a file within that folder) that has been previously backed up, click the "Home" button in Windows Explorer's menu bar, then click "History" in the ribbon that appears. This brings up the File History window for the selected file or folder, and you can then restore the entire folder or files within it as normal.

3 FREE UP SPACE BY DELETING OLDER BACKUPS

At the bottom of File History's "More options" menu, click "See advanced settings." This opens a Control Panel window for File History. On the left, click "Advanced settings." Underneath the drop-down menu displaying how long backups are kept for, click "Clean up versions."


E
Control Panel › System and Security › File History › Advanced Settings
Advanced settings
Choose how often you want to save copies of your files, and how long to keep saved versions.
Versions
Save copies of files:
Every hour (default)
Keep saved versions:
Clean up versions
HomeGroup
Event logs
File History Cleanup
Delete older versions of files and folders
The cleanup deletes versions of files and folders older than the selected age, except the most recent version of a file or folder. All other files and folders, such as versions that were excluded or removed from your libraries, are also deleted.
Delete files:
Older than 1 year (default)
All but the latest one
Older than 1 month
Older than 3 months
Older than 6 months
Older than 9 months
Older than 1 year (default)
Older than 2 years

›› By default, this deletes backups from more than one year ago. If you really want to be thorough, you can tell Windows to clear out everything except the most recent backup [**Image E**]. At the other end of the scale, you can choose to only delete backups from more than two years ago. No matter what you choose, Windows always keeps the most recent backup of a file or folder.

›› If you backed up a file or folder then subsequently deleted it from your computer (so it only exists in your backups), clearing out your backups could mean it's permanently deleted. Make sure you're certain you won't lose anything important before you go down this route.

›› The amount of space freed up in this process depends on the size and number of backups created by File History, but you could find the savings are significant. Still, we recommend holding on to your backups and using a separate backup drive if you run out of space if possible.

RESTORE BACKUPS FROM OLDER VERSIONS OF WINDOWS

Got backups from previous versions of Windows? You can still restore them in Windows 10. Open Control Panel, click "System and Security," then click "Back up and Restore (Windows 7)." Any backups you've previously made are displayed here; click "Restore my files" to browse through files and folders to bring back, or click "Select another backup to restore files from" to choose a backup other than the most recent one. Once you've made your choice, follow the on-screen instructions to restore your data from an older version of Windows.

Unlike File History, the older Windows Backup feature could be used to create a complete system image of any connected drives, as well as being used to back up and restore selected files and folders. As such, these backups are often much larger than those created by File History, and thus take longer to restore.

If you prefer Windows Backup to File History, you can configure it to run on a regular schedule. As with File History, you need to ensure your storage device is connected at the time the scheduled backup is due to run.

Manage Notifications in Windows 10

YOU'LL NEED THIS

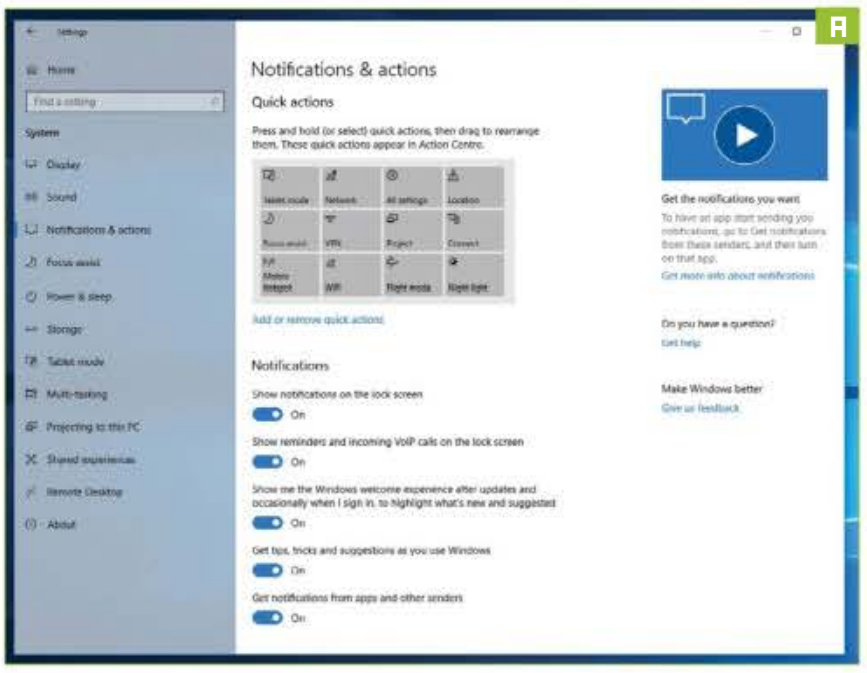
WINDOWS 10
Most of the options you need are in the Settings app.

IF LEFT UNCHECKED, Windows 10 notifications can become pretty bothersome. No one likes to be interrupted when inspiration strikes, yet with Windows 10's default settings, you could find yourself facing a barrage of buzzes and blips demanding your on-screen attention.

Swing too far in the opposite direction, however, and you could miss out on vital reminders and updates. You don't want to totally disable notifications if you're expecting an important email, and things could quickly head south if blocking all notifications means you don't get buzzed that your processor is overheating.

That's why it's important to strike the right balance, and to do that you need to know how to adjust Windows 10's notification settings to your liking. That's what we'll show you in this tutorial, and by the end of it, you'll have the tools to tweak and adjust your PC's alerts to perfection.

Most of Windows 10's notifications options are located in the Settings app. To open it, click the "Start" menu, then click the cog icon just above the "Power" button. Alternately, click on the Windows 10 search bar, type "Settings" and click the first result. That's where we're going to kick things off. **–ALEX BLAKE**


A
Notifications & actions
Quick actions
Press and hold (or select) quick actions, then drag to rearrange them. These quick actions appear in Action Centre.
Add or remove quick actions
Notifications
Show notifications on the lock screen
On
Show reminders and incoming VoIP calls on the lock screen
On
Get tips, tricks and suggestions as you use Windows
On
Get notifications from apps and other senders
On
Get the notifications you want
On your have a question?
Get help
Make Windows better
Give us feedback

1 SET GLOBAL RULES FOR NOTIFICATIONS

Windows 10 allows you to customize your notifications in both broad and fine strokes, enabling or disabling everything at once, or on the individual app level. That makes it well suited to those who just want quick changes and those who want more control alike. To get started, open the Settings app, click "System," then choose "Notifications & actions" on the left.

›› Under the "Notifications" header, there are several toggles that enable you to change various settings [**Image A**]. The first two let you choose whether you see notifications on the lock screen before you log in. These can include messages telling you that you need to update Windows, or alerts that you've missed a Skype call, for example. If you want your lock screen to remain clean and uncluttered, you can disable these, although you might find it useful to keep them around so you don't miss anything.

›› Below that are two settings that relate to the Windows experience. The first lets Windows show you what's new after you've updated the operating system; it also does this "occasionally" when you sign in. The second offers "tips, tricks, and suggestions" while you go about using Windows. If you know your way around Windows 10, you may not find these particularly useful, so you should be safe to turn them off if you want to cut down on notifications.

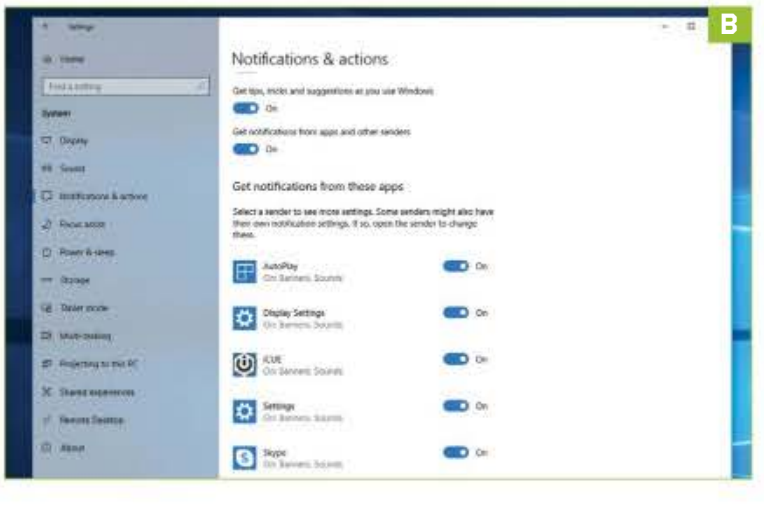
›› The final option in the "Notifications" section lets you allow or block notifications from all installed apps in one fell swoop. Turn off this setting and you won't see any notifications, regardless of whether they originate from a built-in Windows app or a third-party one. You'll notice that if you turn off notifications from apps, alerts are also automatically blocked from the lock screen. If you want to keep notifications from some apps but not from others, you can control that below.

2 MANAGE INDIVIDUAL APPS

Windows 10 gives you fine-grained control over individual app notifications. First, make sure that you are not blocking alerts from "apps and other senders," then scroll to the "Get notifications from these apps" section [**Image B**].

›› Here, you'll see every app you have installed that can send you notifications, as well as a toggle next to its name, enabling you to block all notifications from that particular app. If you just want a simple level of control, you can block and allow alerts with a quick click.

›› You can get a lot more control, however, if you click on an app's name [**Image C**]. As well as being able to switch off notifications here, you can choose what type



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of messages you see. For instance, you can allow an app to show you banner notifications, but stop it from playing a sound when it does so, reducing the level of distraction. Or you can banish on-screen alerts entirely and hide them in the Action Center for when you're ready to see them. These settings are useful if you have a particularly obnoxious app that needs turning down, but you don't feel the rest of your apps need as much reining in.

›› As well as enabling you to hide things in the Action Center, this section of the Settings app also lets you decide how exactly those alerts are displayed once they're in the Action Center. You can limit how many notifications each app can show at any one time, from a minimum of one to a maximum of 20 [**Image D**]. There is also an option to determine the priority of each app's notifications in the Action Center—top priority alerts are always shown above other notifications, and you can also assign them high or normal priority. This setting is especially handy for bringing some order to an otherwise unruly Action Center.

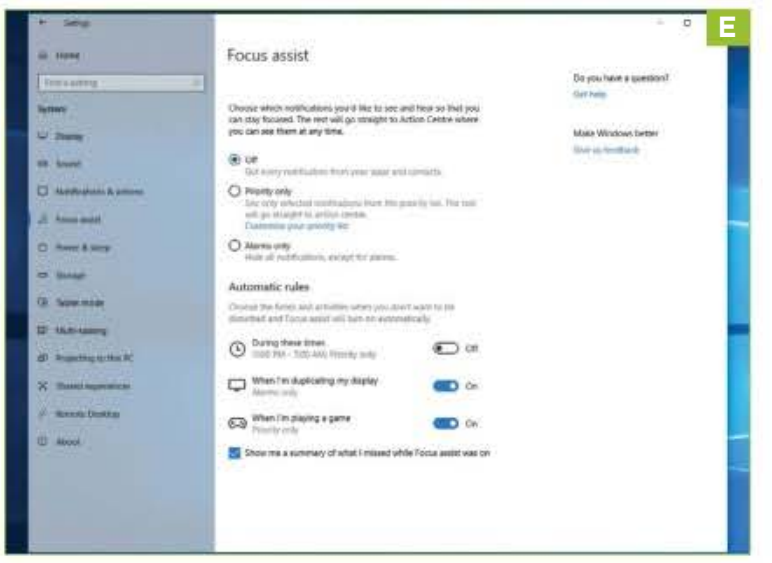
3 USE FOCUS ASSIST TO LIMIT NOTIFICATIONS

You may feel that the options discussed so far are a little too wide-ranging, in that they block or enable notifications at all times. If you only want to mute notifications temporarily—such as when you're busy working—Windows 10 has a built-in feature that can help. It's called Focus Assist, and it works by sending all notifications straight to the Action Center, unless you make an exception. You won't get any buzzes or banners, helping you stay focused when you want to get on with your work.

›› To customize Focus Assist, open the Settings app, click "System," then click "Focus Assist" in the left-hand column [**Image E**]. It's turned off by default, but if you switch it on, you get a couple of options on how it works. One is to block everything except alarms. This is the most restrictive route, but it may be worth taking this nuclear option if you really need to concentrate.

›› The other choice is to only allow notifications from things on your priority list, while everything else is sent to the Action Center. Click "Customize your priority list" to specify what to allow through the Focus Assist firewall. It's worth noting that this isn't restricted to apps—you can specify certain contacts whose communications will be permitted, for example, which is useful if you're expecting a message from someone and can't afford to miss it. If you've pinned a contact to your PC's taskbar, you can choose to have any notifications from them show up there as well as in the Action Center.

›› You can enable Focus Assist using its dedicated button in the Action Center. This makes it much quicker to tamp down notifications without having to go through the Settings app every time. You can click the "Focus Assist" button a couple of times to toggle through priority mode or only allowing alarms through. The Action Center displays a notification reminding you that Focus Assist is enabled, and you can either disable it there and then, or adjust its settings by clicking "Change."



GET CONTROL OVER QUICK ACTIONS

The Action Center doesn't just house your notifications. It's also home to quick actions which, as the name suggests, enable you to do a variety of tasks at the click of a button. Click the "Action Center" button in the bottom-right corner of your display, and you'll see a grid of icons at the bottom of the slide-out window, enabling you to control things such as your network settings, VPNs, or Windows night light.

In the Settings app, navigate to the "Notifications & actions" section, and you can choose which quick actions appear in Action Center and the order in which they're arranged. Aside from Focus Assist, Flight mode (also known as Airplane mode) is especially useful if you need to concentrate, as it switches off all wireless communications; use it in combination with Focus Assist and you can block out all notifications, be they app-based or Internet-based alerts. Of course, that means you won't be able to use the Internet, but if you need to lock things down with absolutely no distractions, it can help.

Link Your Cell to the Your Phone App

YOU'LL NEED THIS

YOUR PHONE COMPANION
Download the app from the Google Play store.

ANDROID PHONE
Plus Windows 10 on your PC.

THE YOUR PHONE APP is a recent addition to Windows 10, but a powerful one. It enables you to use your Android cell phone closely with Windows 10, and works in tandem with an app on your smartphone. That app, Your Phone Companion, is available from the Google Play store for Android phones, and it's that we'll be using for the tutorial below.

If you have an iPhone, there isn't a direct equivalent—Apple restricts other apps from controlling iOS, so it's not possible to use an iPhone alongside Windows in the same way as it is with Android.

There is, however, a corresponding app in Apple's App Store called Continue on PC—it enables you to sign in with your Microsoft account and send web links from your iPhone to your Windows PC. Your PC will appear as an option if you tap "Share." **–DAN GRABHAM**

1 GET CONNECTED

To get started, you need to install the Your Phone app from the Windows Store. To set it up, you need to select the type of smartphone you want to use with the app. As we said earlier, we're concentrating on the Android experience, because using the app with an iPhone only gives you the basic option of sharing information from your phone to your PC, so we're clicking "Android" here, then "Continue."

2 GET THE APP LINK

The Your Phone app then asks to text you a link to the Your Phone Companion app on the Google Play store [**Image A**]. There's no way around this, even if you've downloaded the app already. Make sure you select the right country for your smartphone. Then you can install the app on your Android phone in the usual way—the text link takes you directly to the app on Google Play, and installation is quick.

3 SIGN IN AND LINK

The Your Phone app then asks you to sign in (if Windows 10 isn't already linked to a Microsoft account). On your smartphone, you're asked to do exactly the same. Remember: You need to use the same Microsoft account on your smartphone as you're using on your PC—this is how the two devices communicate. The linking process takes a couple of minutes.

4 VIEW YOUR PHOTOS

Once linked, you can see the content from your smartphone within the Your Phone app [**Image B**]. You can browse recent photos—the last 25 are shown—and it's a nice quick way to get your latest shots on to your computer. Note: They aren't saved on your computer by default—Your Phone isn't a backup tool, like camera uploads in the OneDrive or Dropbox apps, for example.

5 SEND MESSAGES

It's easy to send a message from your computer using the Your Phone app—just click "Messages" on the left and start typing a message in the bottom-right. You can add pictures, GIFs, or emojis [**Image C**]. Your phone contacts should be synchronized with your PC, top-right, with other texts in the middle column. However, this didn't work for us, even though everything else did.

6 CONFIGURE NOTIFICATIONS

If you tap "Notifications" on the left, you'll almost certainly see this screen first [**Image D**]—it requires you to send a notification to your phone to change a setting and grant permission. If you don't do this, you can't get notifications on your PC. It's really not a hassle, although you might have to do it again if it doesn't pop up the first time.

7 VIEW NOTIFICATIONS

Although these notifications pop up on your PC's screen and are viewable within Action Center, you can also see the notifications that are shown on your phone screen [**Image E**]. These include calendar alerts, new emails, WhatsApp messages, or other texts. You can fine-tune what is transferred to your PC using the Your Phone app's settings (click in the bottom-left).

8 THE ANDROID APP

When you start the Android app [**Image F**], you need to sign in with your Microsoft account. You also get other pop-ups—these ask for several permissions, so the app can get access to your phone's photos, messages, contacts, and calls. If you deny these, the Your Phone app won't work.

9 PAIR YOUR PHONE

To make calls through your phone using your Windows 10 PC, you need to go a step further and pair your phone with your PC using Bluetooth [**Image G**]. The Your Phone app then facilitates the calling aspect. We're using a different phone here, because our previous phone was already paired, so we're showing the process of pairing a new phone.

10 READY FOR CALLING

You pair your phone using a number that's shown on screen—it should match the number shown on your phone. You may also get a notification asking you to accept the pair request, and the nature of this notification seems to vary depending on the phone being used. If you have problems, you can pair your phone using Bluetooth settings in the main Windows 10 Settings app [**Image H**].

© MICROSOFT

A

Let's link your Android and PC

To see your phone's photos and reply to text messages on this PC, you'll need to install the Your Phone Companion app on your phone. Enter your number and we'll text you a link to get started.

GB (+44) | 555 555 5555 | Send

By sending your phone number, you agree to receive a one-time automated message from Microsoft to this mobile phone number. Consent is not necessary to get or use the app. Standard SMS rates apply. We'll also save your phone number so you won't have to type it again the next time. You can go to account.microsoft.com to manage your info.

Privacy statement

E

Notifications

Refreshing

Gmail

CBQ HP ZBook styl... · Can we add a final paragraph explain...
added a comment to the following document

New
Can we add a final paragraph explaining in less techie terms why you should perhaps choose over the other? i.e if you care about not needing to charge your pen and a lighter pen device, go for the EMR.

Drive
2 comments on

"Can we add a final paragraph explaining in less techie terms why you should perhaps choose over the other? i.e if you care about not needing to charge your pen and a lighter pen device, go for the EMR."
"Is the sentence finished? If so, should it have a full stop at the end?"

Calendar BF
Today from 14:00-15:00

Calendar BF
14:00-15:00

B

HUAWEI Mate 30 Pro

Photos
Messages
Notifications
Calls (in preview)

Recent photos

Last updated on Refresh

F

Microsoft

Finish linking your phone and PC

To see recent photos and send texts from your PC, you'll need to sign in and allow a few permissions.

Sign in with Microsoft

Privacy policy

Next, app permissions...

We need a few permissions to help your phone and PC work together.

Allow Your Phone Companion to access photos, media, and other files on your device?

DENY ALLOW

C

Nothing to see here... yet.

Troubleshoot issues with messages

Emoji - Keep typing to find an emoji

Tip: Press + period (.) to use emoji in any app

Hello, hope all's well? about the cupboard?

G

Pair Device

Pair device?

Does the PIN on "OPPO Reno2 Z" match the PIN below?

697305

Yes Cancel

d PC

e and PC

D

We need your phone's permission to sync notifications

Select **Open settings on phone** and find **Your Phone Companion** in the list of apps. Toggle on **Your Phone Companion** and select **Allow** when it asks for access.

Open settings on phone

H

Bluetooth & other devices

Add Bluetooth or other device

Bluetooth
On

Mouse, keyboard & pen

Audio

Other devices

Machine of the Month: Commodore Amiga

YOU'LL NEED THIS

COPY OF FS-UAE
An original Amiga Kickstart ROM is optional. FS-UAE runs on Windows, Linux, or Mac OS; 32-bit or 64-bit builds are available: https://fs-uae.net.

THIS MONTH, WE CONTINUE the 16-bit battle between the Atari ST and the Commodore Amiga, where engineers from each company switched sides for one of the weirdest rivalries in computing history. This time, we're focusing on Commodore.

A cult favorite in the US and a computing goliath in Europe, the Amiga was a multimedia powerhouse way ahead of its time, with functionality PCs would struggle to replicate for the next two decades.

From its jaw-dropping audio-visual demos, to its brilliant sound and image editing, the Amiga would quickly establish itself as an industry favorite among artists and content creators. In spite of a slow start, its multiple advanced processors and 16-bit CPU would eventually usher in a new era of gaming possibilities.

Despite its success worldwide, Amigas are relatively rare in the US, leaving emulation the only real option for all but the most hardcore users. Emulating it isn't always easy, so let us do the hard work, so you can hit the ground running with this beautiful machine. –JOHN KNIGHT

1 ONCE UPON A TIME...

The Amiga's story begins at Atari. Disgruntled engineers had left the company after failing to interest management in a 16-bit machine, based on the Motorola 68K CPU. In 1982, they created their own company: Hi-Toro, later renamed the Amiga Corporation. Over in Commodore land, CEO Jack Tramiel would leave the company in early 1984 and buy Atari's consumer division, giving himself an established brand to sell products under—chiefly his new 16-bit computer, the ST.

›› Unfortunately for Commodore, Tramiel swiped its most important engineers to work on his machine, and Commodore didn't have enough engineers to create a new 16-bit computer. Meanwhile, Amiga was bleeding cash and owed money to Atari after a rather predatory loan. As Commodore needed a new machine, it simply bought out Amiga, paid off the debt to Atari, and rebranded the Amiga as its own.

›› Launched in July 1985 as "The Amiga from Commodore" (later the Amiga 1000), it was a month behind the Atari ST. The Atari put up a strong fight with a lower price and twice the RAM, but the Amiga had a large 4,096-color palette, a proper multitasking GUI, and a far superior sound chip. More importantly, the Amiga was designed around multiple co-processors for audio, video, and memory access, thereby freeing up the CPU, and generally outperforming its competition.

›› Modification was popular, and it was common to fit expansion boards with a second CPU, allowing Mac or PC functionality. The Amiga quickly branched off into different, more advanced models, but it was the budget Amiga 500 that was the real hit.

2 THE MOMENTUM FINALLY HITS

Released in 1987, the 500 was almost half the price of the 1000 launch. Costs were cut by repackaging the bulky desktop case into micro form, new chipsets allowed a simplified design, and lower RAM prices allowed 512K of RAM. Selling in normal retail outlets made the 500 the best selling Amiga, where it finally won its reputation as a formidable games machine.

›› If you're American and well familiar with Amigas, you've probably been involved in the film or television industry. By combining an Amiga 2000 with NewTek's Video Toaster (1990) expansion card, users could "genlock" with video signals, matching their refresh rates, allowing video overlays and easy effects. For a few grand, someone could get into professional video editing for less than a tenth of the cost of existing systems.

›› Like the Atari, the Amiga never really took off in North America, despite being American itself. The Amiga sold nearly five million machines in its lifetime—against Atari's 2.2 million sales—most of which were in the UK and Germany, with only around 700,000 sold in the US. Therefore, most software is European, designed for PAL machines.

›› The Amiga continued evolving, with 32-bit models in the '90s, and a failed attempt at the console market with the CD-32. As the '90s progressed, PCs were getting cheaper and Commodore could no longer compete, filing for bankruptcy in 1994. Nevertheless, you can still buy Amiga clones, and AmigaOS is still going, along with its rival, MorphOS. Both run on PowerPC, if you want to make use of an old Mac.

3 HOW TO EMULATE IT

Before we continue, serious users should consider commercial packages such as AmiKit and Amiga Forever, which integrate Amiga emulation into your desktop, preloaded with many classic Amiga

›› Advanced video hardware allowed games such as 1991's *Another World* interactive animation—it's still impressive.

© ANOTHER WORLD, DELPHINE SOFTWARE

›› Despite a slow start, the Amiga would provide astonishing desktop and multimedia abilities many years before the PC.

programs. If you want to use an Amiga desktop as your actual OS, there's AROS, an open-source re-implementation of AmigaOS for standard x86 PCs and Raspberry Pis. Icaros (https://vmwaros.blogspot.com) is the most popular version.

›› Our preferred emulator is FS-UAE, available on Windows, Linux, and MacOS. For Windows, the recommended download includes a GUI interface and an executable installer. For Linux, packages should be in your distro's repository, but make sure you install not just the fs-uae package, but also fs-uae-launcher.

›› If these packages are older than the current release, the current version is in the main download, providing a tarball with precompiled binaries. Just extract the package, open a terminal in that folder, and enter the command:

```
$ ./Launcher
```

›› Before running any programs, you need to define your machine, which will be under "Amiga Model" in the main tab. Now for the tricky area of system ROMs: FS-UAE comes with an open-source replacement ROM, but its compatibility rate is very hit and miss. You'll have much better luck with a proper "Kickstart" ROM—the proprietary ROM used to run Amigas.

›› There are many nefarious websites with these ROM images, but legally these rights belong to Cloanto, which ships Amiga Forever, containing the Kickstart files. If you are using a Kickstart ROM, the most common Amiga model was the 500, so we recommend choosing A500 as the model, with a 1.3 ROM. If you're using FS-UAE's ROM, we had the most luck setting the Amiga Model to A1200.

›› Unfortunately, we only have room for showing how to run .adf disk files—equally as common are .lha files, but these take far too much preparation to document here. To load something, the main tab has a "Floppy Drives" section, but this really only works for single disk programs. For anything using multiple disks, open the "Floppy Drive" tab. Click the button on the right to browse for disk image files. For additional disks, press the "+" sign in the "Media Swap List."

›› Click "Start" to launch the emulator. Once it's running, Alt-Enter engages full-screen. By default, FS-UAE emulates the joystick on the keyboard, with the arrow keys for directions, and right Ctrl for the fire button. F12 opens a menu where you can pause the system, load and save states, redefine inputs (such as adding a real joystick), and change removable media.

›› The removable media is where you change disks when prompted mid-game. To change a disk, simply press Enter on the current disk, then you're given the selection of disks you defined earlier.

FIND SOFTWARE

Although niche, Amiga software is still an active ecosystem, with development and commercial usage continuing to this day. You can find plenty of software on Archive.org, usually in .adf format, covering all types of software, including magazine coverdisks.

If you're willing to research how to run .lha files—though there are some .adf files, too—Aminet (https://aminet.net) has an exhaustive archive. The Amiga community has relied on Aminet since 1991 and still uses it now. There is all the software you could want, as well as archives of fanzines, pictures, and more.

It would be remiss of us to leave out the Amiga's massive public-domain demo scene, where coders compete for the most spectacular multimedia demonstrations, often squeezed on to just one floppy disk. The Amiga Demoscene Archive (https://ada.untergrund.net) has demos from the '80s right up to the present. It's mostly in .lha format, but still worth browsing.

SPECIFICATIONS

Commodore Amiga 500 (1987)

CPU:	Motorola 6800 @ 7.16MHz
RAM:	512KB
Launch price:	$699
Graphics:	704x484, 32 colors
Sound:	MOS Technology Paula
Storage:	880KB floppy disks
OS:	AmigaOS v1.2
Released:	April 1987 (Netherlands), October 1987 (US)
Production:	1987–1991
Worldwide sales:	5 million

›› Spectacular public-domain demos are perhaps even more important to the Amiga than games.

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Focus Stacking in Affinity Photo

YOU'LL NEED THIS

AFFINITY PHOTO
Find out more or purchase it from https://affinity.serif.com.

CAMERA
With manual focus ability.

FOCUS STACKING IS A TECHNIQUE in which you take several shots of a subject from the same standpoint—usually a tripod-mounted camera—but with the lens's focus ring set to different distances every time you open the shutter. This way, a macro photograph that would usually have a naturally shallow depth of field can be manipulated to have the whole subject in focus.

You do need to put a bit of work in to create the raw materials for this one before you start processing. You need a lens that can be manually focused, a way of securing your camera so it doesn't move and ruin everything (as much as you think you might, you won't be able to achieve this handheld), and enough patience to make a really good job of it. As you will see, we lacked one of those things.

The ability to focus stack is built into many image-editing apps, including Photoshop and Affinity Photo—we're using version 1.7.3 of the latter. It's a similar technique to HDR stacking, but instead of merging the color information from your files, you're sticking together the bits that are in focus. **–IAN EVENDEN**

1 TAKE THE PICTURES

We mounted a full-frame DSLR on a tripod, attached a 100mm macro lens, and set it to manual focus and f/2.8. Using the screen on the back of the camera, we racked the focus back so the closest end of the DIMM to the camera was in focus. With the camera in single-shot mode, we fired a frame and moved the focus point slightly farther away before repeating the process. We learned something from this: Be patient. Move the point of sharpest focus very, very slowly away from the camera, because too much of a jump results in a blurry patch in the final merged image. It took us 11 images to travel the length of the DIMM, and this wasn't really enough. For a second try, we used a cable release and set the camera to its fastest frame rate, jamming down the button and very slowly adjusting the focus while the camera machine-gunned away. This time we created 32 files, each looking much the same [**Image A**], but with the focus point in a different place. However, we hit a problem with the camera's buffer, meaning the capture wasn't as smooth as we would have liked. We shot in JPEG here, not raw as we usually do, because there seemed little point in creating a lot of data to move around when we would be throwing most of it away. The greater number of files resulted in a better merged result, but there are still some soft spots.

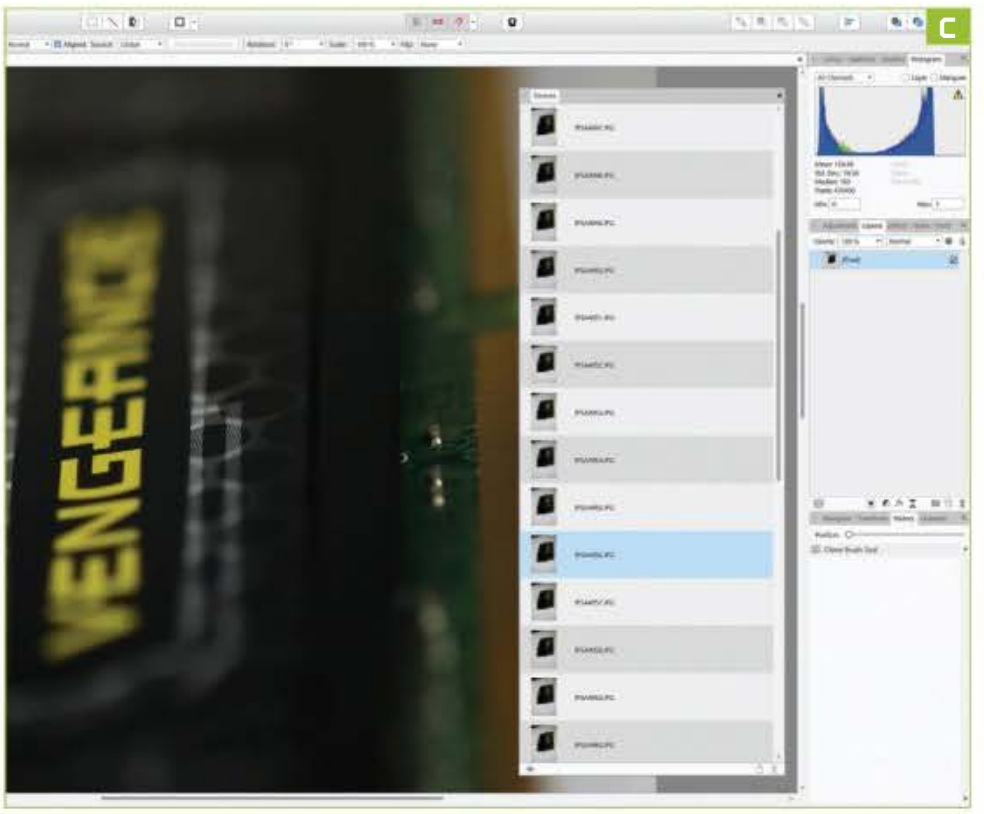
2 MERGE THE IMAGES

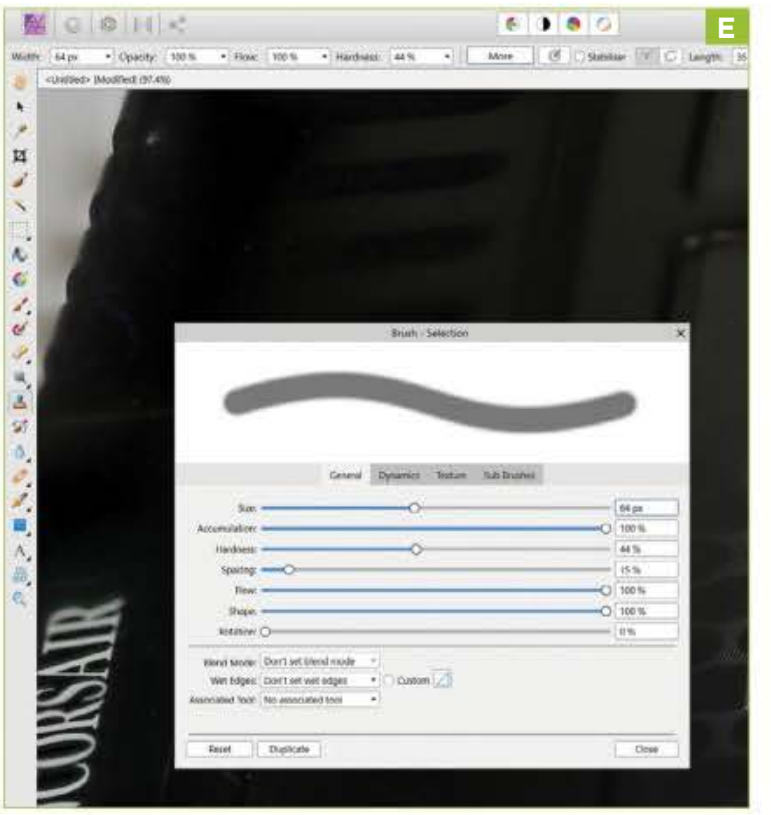
Create a new folder in your Photos folder or elsewhere, and put all the images in there. Open Affinity Photo and select "File → New Focus Merge." In the window that appears, click "Add" and navigate to the folder you created. Click on an image, then press Ctrl-A to select every file in the folder. Hit "Open." Back in the Merge window, check no rogue files have crept in (select them with the mouse and press "Remove" if they have), then hit "OK." The process is automatic, and can take a long time if you're merging a lot of high-megapixel images on a slow CPU. You get an idea of how things are progressing thanks to a progress bar and the changes made to the image on screen in real time [**Image B**].

3 SOURCES

When finished, you'll see your new image on a single layer, plus a palette named "Sources," in which you'll find the files that were used to build the composite [**Image C**]. You can use these to touch up bits of your image that aren't quite right. Note that even if you save as an .afphoto file, the Sources list isn't preserved, so this is your only chance to fix bits that don't look right.

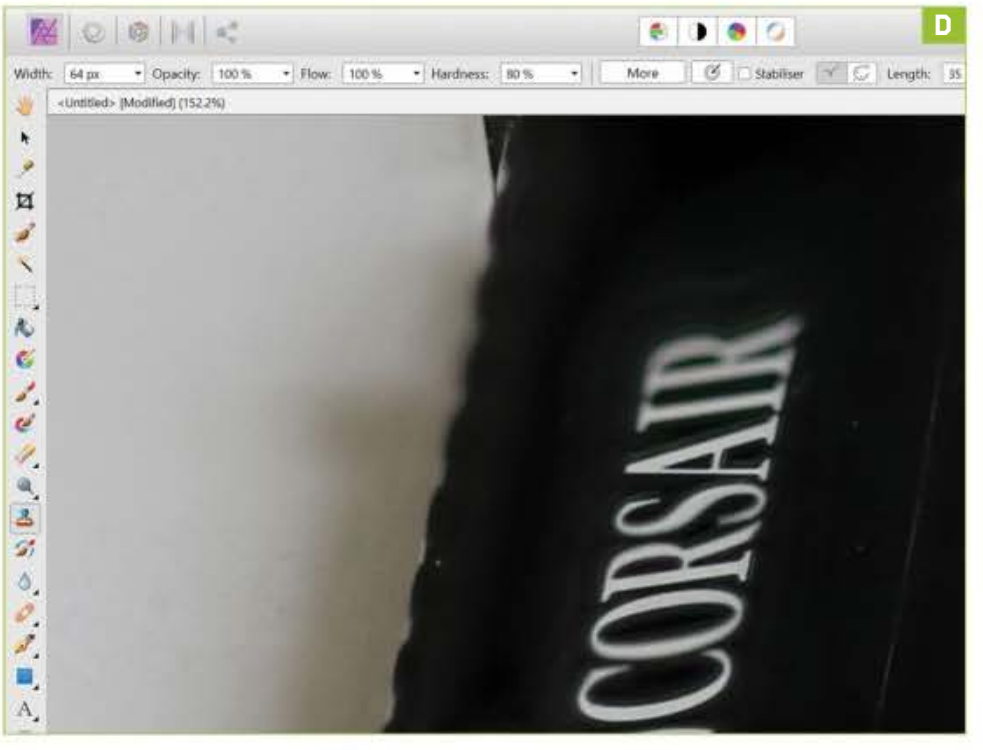
© AFFINITY PHOTO





4 CLONING PREPARATION

Affinity Photo's Clone brush works in the same way as the one in Photoshop. You hold Alt to define a source, then as you paint, that source is duplicated. If you want to clone from the Sources window, make sure you have the Clone Brush selected (it looks like a rubber stamp, two thirds of the way down the toolbar), then on the Sources palette, double-click images until you find the one you're looking for—the one that's sharp where the composite is soft. Spots like these happen fairly commonly, and if you can't find a way of cloning in some sharper pixels, you will need to shoot all the images again, this time with a slower focus rack, or using a smaller aperture to increase the depth of field in the individual frames. Specular highlights, in which balls of white are formed by shiny bits that go out of focus, seem particularly able to fool the merging algorithm, forming rings of white around otherwise perfectly sharp features. It's worth identifying the source of these and painting over them. Likewise, if your lens is prone to focus breathing, where objects change size as they go in and out of focus, you can get a soft border around high-contrast areas that needs to be carefully brushed away [**Image D**].



5 CLONING

Once you've found a suitable source, leave it selected, and find the eye icon hiding at the bottom-left of the Sources palette. Choose this, and you're returned to the composite, but now your Clone Brush is loaded with the single source frame as though you'd Alt+clicked it. Start painting. It's a good idea to keep the edges of your brush fairly soft, so your new strokes blend in with what's already there. There's a "Hardness" slider at the top-left of the interface, along with brush size and opacity, or you can hit the "More" button for a floating palette you can change on the fly [**Image E**].

6 FINISHING UP

Each brush stroke appears in the History palette, so paint in smaller strokes if you want to be able to undo mistakes without having to redo large areas. Save as an .afphoto file to preserve layers, but remember that your Sources will be gone as soon as you close the file, so make sure that you're really happy before you close the image.

CHOICES, CHOICES...

If you're really into this technique, or think it might help in a project you're working on, there are other apps besides Affinity Photo that can achieve the same effect, some of them free. Full-size Photoshop CC can manage it, although the cut-down Photoshop Elements can't. CombineZP and Picolay, both free, were made with microscopes in mind, but can handle any stack of image files. They don't have a lot of options, but get the job done. Helicon Focus, which is $115, but offers a free trial, is a pro tool with plenty of options for professional scientific macro photographers. It can even superimpose an accurate scale bar on your image, perfect for demonstrating the size of the strange insects you found nesting between your RAM sticks.

BUILD IT

CHRISTIAN GUYTON, STAFF WRITER

Put Together a Party PC

Build a gaming PC you can take to a friend's place

LENGTH OF TIME: **1-2 HOURS**

LEVEL OF DIFFICULTY: **MEDIUM**

THE CONCEPT

DO YOU MISS LAN PARTIES? We do. The steady erosion of split-screen multiplayer and improvements to online play mean that the tradition of gathering at your best friend's house, setting up bulky CRT monitors, and connecting cables all over the place so that you could all play *Quake II* together is a distant memory .

Well, the LAN party isn't dead just yet—at least, not if we've got anything to say about it. We've got a challenge for you: Grab a few friends and a few drinks, and set up as many systems as you can in one room for a proper old-fashioned game night. So, this month, we're gonna be building a compact PC designed to be taken over to a friend's place for a spot of co-op (or competitive) gaming.

This gave us a few preordained necessities to work around. An ITX form factor motherboard was basically mandatory, squeezed inside a small case. However, we also needed a decent graphics solution; integrated graphics on an APU simply wouldn't cut it here, so a discrete GPU was needed. Alongside all this, we also needed a decent amount of memory and an SSD—hard drives are too bulky for compact builds.

The other element we wanted to capture was portability. No, this won't be a system you can break out on the bus, but it needed to be light enough to carry around easily and compact enough to fit comfortably in the trunk of a small car. Minimal internal cabling and a low-profile CPU cooler were also preferable features, and we knew there had to be at least some RGB lighting—this is a gaming PC, after all.

COUCH COMPONENTS

OUR COMPACT CASE was an easy choice: Cooler Master's MasterCase H100. We recently reviewed it, determining that it was one of the best ITX cases we'd seen in ages, and guess what—it comes with a carry handle on top, too. It was a no-brainer.

The rest of our list was more complex. We needed an ITX mobo, so reached out to Asus for a ROG Strix B450-I Gaming. A recent price drop made this high-quality board more affordable, so we couldn't say no. It's worth noting that new B450 boards purchased from Asus now come pre-flashed, making them compatible with second and third-gen Ryzen CPUs straight out of the box.

We're using the Ryzen 7 2700; a last-gen chip, but it remains a solid eight-core CPU. We're not using a third-gen Ryzen chip to keep the price down. B450 chipset boards don't support PCIe 4.0, so we wouldn't be able to take advantage of an ultra-speedy fourth-gen M.2 SSD anyway. It had to be M.2, though, rather than a larger SATA SSD—being able to install the drive directly to the motherboard means one less cable getting in the way. With that in mind, we selected XPG's 512GB Gammix S10 SSD.

We're using the stock cooler that comes with the CPU, the AMD Wraith Spire. Fortunately for us, it just falls below the maximum CPU cooler clearance for this case. The reason for the minimal cooler clearance is simple: In order to save space, the MasterCase H100 requires you to mount your PSU vertically alongside the motherboard, at the top-rear of the case.

Our PSU is Fractal Design's excellent Ion+ 560P, a fully modular power supply for just 100 bucks. We needed a small GPU, too, so we've gone for PNY's GTX 1660 Ti XLR8, a single-fan factory overclocked model of Nvidia's excellent mid-range GPU. Lastly, we've got 16GB of Micron's 2,400MHz Ballistix Sport RAM.

INGREDIENTS

PART		STREET PRICE
Case	Cooler Master MasterCase H100	$70
Motherboard	Asus ROG Strix B450-I Gaming	$135
CPU	AMD Ryzen 7 2700	$150
CPU Cooler	AMD Wraith Spire	N/A
Memory	16GB (2x 8GB) Ballistix Sport LT White @ 2,400MT/s	$66
GPU	PNY GeForce GTX 1660 Ti 6GB XLR8 Gaming	$240
PSU	560W Fractal Design Ion+ 560P 80+ Platinum	$100
SSD	XPG Gammix S10 512GB	$80
OS	Windows 10 Home 64-bit	$100
Total		$941

1 SMALL PACKAGES

START BY STRIPPING DOWN THE CASE. Only one side panel can be removed from the MasterCase H100, so take that off and set it aside. You can remove the plastic front cover—it pops off easily—but there's no need. You do, however, need to remove the two expansion card blanking plates and the mounting bracket for the PSU at the rear. To prep it for later, remove the PSU block from its box and screw the bracket on to it, using four of the larger screws from the H100's accessory bag. Keep this bag handy; it also has cable ties and the screws you need to secure the mobo (we aren't using the included RGB controller, though). Lastly, make sure the front I/O cables are neatly secured to one side, so they don't get in the way when it's time to install the motherboard.

2 SHIELD BEARER

BEGIN THIS BUILD PROPER with motherboard assembly. Start with the M.2 drive; the Gammix S10 comes with its own heatsink attached, so rather than remove that, we'll simply go without the heat shield that comes on the motherboard. Unscrew it at both ends (being sure to store the screws in the B450-I's box), and slot the SSD into the M.2 port. Push the drive down and screw it into place using the tiny silver screw—it should be situated in the stand-off, but if not, you'll find it by itself in a tiny bag in the motherboard box. With the drive in place, move on to the memory. This is simple: Release the clasps at one end of the DIMM slots, then push each stick down until it clicks into place at both ends. Don't be afraid to apply a little force; you'll know when the sticks are secure.

3 CONCEALED COOLING

DON'T MAKE THE MISTAKE of assuming that fitting the cooler once the mobo is inside the case is easier. It isn't. Raise the retention arm and slot the CPU into the socket, lining up the triangle markers in one corner, then lower the arm to secure it. With that done, you'll likely need to remove the plastic brackets from either side of the socket; we only need the metal backplate to install this cooler. Once the plastic parts are unscrewed, deposit a small glob of thermal paste on the CPU and lower the Wraith Prism on to it, lining up the four screws with the holes in the mobo. Screw it to the backplate until it's secure, then plug it into the CPU fan header on the board. You can unplug the RGB cable; you won't be able to see the small light ring once the PSU is fitted, anyway.

4 MOUNT AND MADE

LET'S MOUNT THAT MOTHERBOARD. This can be a somewhat awkward process thanks to the cramped interior of the case, so get everything set up first. You need four of the small motherboard screws from the case accessories bag, as well as the rear I/O shield that came with the board. Slot that into place on the back of the case, then carefully lower the motherboard into position, ensuring that it lines up properly with the holes in the I/O shield. You may need to hold the board in place to get the first screw in, as the back of the shield is squishy and pushes the board off its stand-offs if you release it. Focus on the two screws closest to the shield first, and the other two should come into place. Once the motherboard is fully secured, it's on to the next step.

5 GRAPHIC VIOLENCE

WE HAD FEW IDEAS for which GPU should go in this build. Our original plan was to use AMD's RX 5500 XT, but our unit proved too large for the case. So, we delved back into the storeroom to examine our options. First up was a Gigabyte GTX 1050; a twin-fan affair that was small enough, but not as powerful as we'd like. We settled on the GTX 1660 Ti XLR8 from PNY, with one larger fan. Before fitting it, though, connect all the front I/O cables to the mobo—the small form factor means these can be awkward, especially the tiny button control cables. Once these are all in place, lower the GPU carefully into the case and push it into the PCIe slot until it locks into place, then screw it down at the rear of the case using the two screws you removed from the blanking plates earlier.

6 HIGH POWER

LASTLY, THE POWER SUPPLY. Due to the limited space, the best approach is to plug in the cables first—the large ATX cable, CPU power cable, and PCIe cable for the graphics card—and feed them out through the back of the case. Connect them to the PSU, then turn the case on its front (with the front cover on if you removed it) and lower the PSU into the slot so the fan is facing out from the case. Screw it down, then it's time for cable management. The large exposed fan means that loose cables need to be kept out of the way, so we recommend using cable ties to bundle the power and I/O cables separately. There are few points to anchor cable bundles to in this case, but the drilled slots in the metal frame that mounts the case fan can be used, if you snip off any excess cable tie length.

1 We had to remove the PSU for this shot, because it effectively blocks the view of everything inside the case. The modular design is a lifesaver here.

2 The Wraith Spire fits snugly underneath the power block, which isn't ideal, but there's still enough space for the cooler to draw in sufficient air for cooling.

3 The large fan at the front of the case isn't too loud, and does a fantastic job of keeping powerful airflow within the case. It's also impressively vibrant.

4 A single fan means that the XLR8 GPU fits perfectly inside this case. The GTX 1660 Ti is also the ideal GPU for a competent 1080p gaming system.

READY TO (LAN) PARTY

THERE WERE UPSIDES and downsides to this build. We were satisfied with the GPU's performance at 1080p, as it comfortably handled our gaming benchmarks and the single fan kept it cool. In fact, this build ran cold throughout our testing; the case fan is brilliant, keeping the whole motherboard chilled. The CPU idled below 30 C, and even heavy stress-testing barely saw temperatures rise much higher than 60 C.

At these low temperatures, the Ryzen 7 2700 performed well, making good use of its 16 threads. We don't overclock our CPUs for benchmarking, but the 2700 definitely has the headroom. Ryzen Master's auto-overclocking options are useful if you prefer not to meddle with the BIOS. Perhaps we should've selected a third-gen Ryzen chip, but we're happy with the numbers we got.

Had we done that, it would have driven the price up significantly. We'd have wanted an X570 motherboard, and the selection of ITX boards with that chipset is limited, plus the price would've risen by close to a hundred bucks. We would be able to use a PCIe Gen 4.0 SSD, however, and the Gammix S10 drive was the main weak point of this build.

While the SSD was well priced and outperformed any SATA III drive we could have used, the numbers were lower than we'd hoped for. A good M.2 SSD should be able to hit at least 3,000MB/s read speeds, but the S10 peaked below 2,000MB/s across multiple tests. In practical terms, though, this shouldn't be much of a problem for a gaming build; M.2 drives are so much faster than HDDs that games should load quickly anyway. The difference between the S10 and a faster SSD probably means load times of two seconds instead of one in many games.

Power-wise, we might have wanted a less powerful PSU. The Ion+ is good, but 560W is more than we need. However, a fully modular supply was necessary due to the case, and it's hard to find a good one under $100. Cable management was hard enough already; introducing excess cables from a non-modular PSU would be a nightmare.

Connectivity-wise, both the mobo and GPU work well. Our LAN-party-inspired choices mean this rig can be hooked up to a monitor or TV via DisplayPort, HDMI, or DVI ports. The lack of USB-C ports is a shame, but between the front and rear I/Os there are eight USB-A ports, so plugging in multiple controllers for a spot of couch gaming is an option, too. There are a few things we'd change if we built this PC again, but we're reasonably happy with how it turned out.

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	1,152	1,553 (35%)
CrystalDisk QD32 Sequential Read (MB/s)	3,400	1,808 (-47%)
CrystalDisk QD32 Sequential Write (MB/s)	1,720	879 (-49%)
Rise of the Tomb Raider (fps)	60	99 (65%)
Total War: Warhammer II (fps)	46	61 (33%)
Tom Clancy's Ghost Recon Wildlands (fps)	39	51 (31%)
3DMark: Fire Strike (Index)	11,101	14,627 (32%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an AMD Ryzen 5 1600, 16GB Crucial Ballistix Sport LT @ 2,666MT/s, an EVGA GeForce GTX 1060 3GB and a 250GB Samsung 960 Evo M.2 PCIe SSD. All tests performed at 1080p at the highest graphical profile.

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TESTED. REVIEWED. VERDICTIZED.

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Corsair Vengeance 6182

You'd struggle to find a better all-around AMD build

SINCE THE RELEASE of Ryzen's second-gen CPUs in 2018, AMD has gained some serious hardware clout. Even so, it's not often we get our hands on an all-AMD rig. But it's the third-gen Ryzen CPUs and 5700-series graphics cards that have finally given gamers real choice when it comes to high-end power, and Corsair's new Vengeance PCs (6180 and 6182) are just the first in what could grow into a healthy ecosystem of AMD-based builds.

There isn't much difference between the 6180 and 6182 models, so while we've reviewed the 6182 here, you can safely expect the same core performance between the two. The only differences are the motherboards, SSD, and price. The 6180 comes with a B540 chipset and 460GB of SSD space, while the 6182 comes with a X570 chipset and 1TB of SSD space. The rest of the specifications are the same—plus or minus a few USB ports—priced at a reasonable $1,899 and $1,999 respectively.

The Vengeance 6182's dual-chamber case showcases the GPU, RAM, and other flashier components on the tempered glass side with such clarity that you can't help but be drawn in by the RGB lighting reflecting off the components. The opaque side houses the PSU and other non-eye-candy components.

Compared to the previous-generation 5180, which used an Intel Core i7-8700 and an RTX 2080 (and was $400 more at release), Corsair's AMD Vengeance 6182 performs near or on par in both synthetic and in-game benchmarks. Multicore and single-core Cinebench scores for the AMD Ryzen 7 3700X topped out at 2,049 and 198 respectively (without an overclock). 3DMark scores for the RX 5700 XT were lower than the RTX 2080, so no surprise there—about 100 points lower at a 1440p resolution and 300 lower at 4K—but actual in-game performance was more evenly matched.

GAME CHANGER

We've updated our testing procedures with different games since the 5180 review, but we did test *Shadow of the Tomb Raider* and *Ghost Recon: Wildlands* at 1080p, too, for a better comparison—103fps on *SoTR* and 60fps on *Wildlands* on the 6182. The 5180 fared a little better, with 113fps and 75fps respectively.

This makes the pricing scheme for both the current 5181/5182 and new 6180-series interesting. Not only is there a better motherboard and SSD storage in the 6182 compared to the 6180, but there's also faster RAM than the 5182, and both the 5182 and 6182 cost $1,999. The 5181, which has a larger SSD than the 5182 and 6180, but no secondary storage, is $1,899, like the 6180. However, the 5181 and 5182 both have an RTX 2070 Super, which is faster than the RTX 5700 XT. In terms of which model has the "better" components, they are all evenly matched when breaking it down like that.

It's worth noting that the Vengeance 6182 is only available from Corsair's own website, while the 6180 and 5182 models are available on Amazon. And as usual with pre-builds, DIY with the same parts costs a few hundred dollars less—but, of course, that doesn't include the cost of labor or the two-year warranty. Strange pricing scheme aside, there aren't any glaring flaws with the Vengeance 6182 gaming desktop. It's compact. It's quiet, even when under stress. It's a competitively priced, high-end rig that's uniquely good looking.

If ray tracing is a must-have, sacrifice faster RAM, a faster and larger SSD, and a better motherboard, and go with the 5182 for the same price as the 6182. The 2070 Super is a better card than the RX 5700 XT, but it's only six percent faster, and both cards can perform comfortably on ultra at 1080p and 1440p. The best value, though, is the Vengeance 6182, a smart, overclockable investment when you consider the full specs. Upgrade the graphics card in a couple years, and the rest of the system should still be going strong. **–JOANNA NELIUS**

VERDICT **9** KICK ASS!

Corsair Vengeance 6182

AM-DO Good case and airflow; reasonable price; excellent choice of components.

AM-DON'T Somewhat strange pricing scheme; CPU and GPU do not come overclocked.

$1,999, www.corsair.com

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	2,178	2,050 (-6%)
CrystalDisk QD32 Sequential Read (MB/s)	3,136	4,995 (59%)
CrystalDisk QD32 Sequential Write (MB/s)	2,126	4,285 (102%)
3DMark: Fire Strike Ultra (Index)	6,988	6,288 (-10%)
Total War: Warhammer II (fps)	42	41 (-2%)
Tom Clancy's The Division 2 (fps)	38	34 (-11%)
Metro Exodus (fps)	37	35 (-5%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point consists of an Intel Core i9-7900X, 32GB of G. Skill Ripjaws V @ 3,000, an MSI GeForce GTX 1080 Ti Gaming X, and a 512 GB Samsung 960 Pro M.2 PCIe SSD. All tests were performed at 4K at the highest graphical profile.

SPECIFICATIONS

Processor	AMD Ryzen 7 3700X
Graphics	AMD Radeon RX 5700 XT 8GB
RAM	16GB (2x 8GB) Corsair Vengeance RGB Pro DDR4-3200
Motherboard	ASRock X570M Pro4
Storage	Corsair Force MP600 1TB PCIe 4.0; 2TB 7,200rpm HDD
Cooling Solution	Corsair H100i RGB Platinum 240mm
PSU	Corsair RM650 80 Plus Gold
Case	Crystal Series 280X RGB
Warranty	Two-year standard

One of the best desktop PCs when looking at cost versus performance.

Sapphire's RX 5600 XT demolishes most other models in terms of boost clocks.

AMD Radeon RX 5600 XT

Performance to shake up the mid-range market

AMD'S RADEON RX 5600 XT has joined the battle for the best graphics card. It's a cut-throat competition, especially when it comes to mainstream GPUs that cost around $300 or under. AMD's RX 5600 XT announcement is a great example of this—the company announced initial specifications and pricing, and Nvidia responded with a price cut on the RTX 2060. Then AMD counter-attacked with an updated RX 5600 XT VBIOS that boosted clock speeds and performance. It's all a bit tit-for-tat.

As far as the core hardware goes, the RX 5600 XT plays it straight. This is the same Navi 10 GPU as the RX 5700, but with 6GB GDDR6 instead of 8GB. It has the same 2,304 GPU cores, but with potentially lower clock speeds. There are no "reference" RX 5600 XT cards, which means most GPUs will be factory overclocked. We've included specs for the Sapphire RX 5600 XT Pulse that we're testing for this review.

Officially, the TDP of the reference model is 150W, and the "performance" BIOS for the Sapphire Pulse has a 180W TDP. In practice, the power use with the high-performance BIOS fell well short of 180W during gaming tests.

The problem is that AMD is still missing a direct answer to Nvidia's ray-tracing capable RTX series hardware, which will likely come later this year as a high-end offering to compete with the likes of the RTX 2080 Super. Until then, the RX 5600 XT is supposed to fill the gap between the RX 5500 XT and RX 5700.

Even before we hit the performance numbers, it feels like the RX 5600 XT is priced a bit too high. We won't be surprised if the street pricing on these cards starts high, then drops closer to $250. Regardless, the mainstream $200-$300 bracket is very congested—there's lots of options, including previous-gen GPUs that are still floating around.

1080p medium is an easy hurdle for the RX 5600 XT. At these settings, the RX 5600 XT is 17 percent faster than the 1660 Ti, 20 percent faster than the 1660 Super, and 6 percent slower than the RX 5700. For a $280 graphics card, that's a strong showing. It's important for it to perform well at 1080p ultra, and it does. All of the test games still break 60 fps; less demanding games won't be a problem.

AMD isn't marketing the RX 5600 XT as a 1440p or 4K card, though it can handle some games at those settings. At 1440p ultra, the 5600 XT closes the gap with the RTX 2060, but each GPU still claims individual wins in various games. The lead over the GTX 1660 Ti and Super increases as well, while the RX 5700 lead also starts to grow. If you have a 1440p display, playing at medium or high should get 60fps or more in quite a few games.

We haven't investigated overclocking potential fully on the RX 5600 XT, but it seems to behave similarly to other Navi GPUs. The "performance" VBIOS update did boost performance about 10 percent, but that also likely means less headroom for additional overclocking. If you're willing to increase the fan curve to improve cooling, getting another 10 percent or so from the GPU clocks shouldn't be too difficult with perseverance.

The Radeon RX 5600 XT performs well, and is certainly worth considering, but is it good value? Calculating "value" isn't an exact science. What GPU do you have right now, how much will it cost to upgrade, or are you building a new gaming PC? If it's the latter, you're usually better off spending more on the GPU. If you're looking to upgrade, on the other hand, the RX 5600 XT is decent value—better than some cards, not as good as others. It varies by regional pricing as well, not to mention any sales you might find, but for the level of performance you get, the RX 5600 XT is a great option. **–JARRED WALTON**

BENCHMARKS

	AMD Radeon RX 5600 XT	Nvidia GeForce GTX 1660 Super
Tom Clancy's The Division 2 (Avg fps)	**90/73**	70/45
Assassin's Creed Odyssey (Avg fps)	**62/48**	53/42
Far Cry 5 (Avg fps)	**118/98**	95/65
Shadow of the Tomb Raider (Avg fps)	**102/78**	85/56
The Outer Worlds (Avg fps)	**89/63**	81/54
Metro Exodus (Avg fps)	**68**/34	53/**40**
Total War: Warhammer II (Avg fps)	**83/60**	71/54

Best scores are in bold. Our test bed consists of an Intel Core i9-9900K, 16GB of G.Skill DDR4-3200, an MSI MEG Z390 Godlike, and a 1TB Samsung 970 Evo M.2 SSD. All games are tested at their highest graphical profile with AA turned on, at 1080p and 1440p respectively.

VERDICT **8**

AMD Radeon RX 5600 XT

RAD Nearly as fast as the RX 5700; power efficient; great for 1080p.

MAD Pricing a bit high; can struggle at 1440p; no ray-tracing support.

$280, www.amd.com

SPECIFICATIONS

GPU	Navi 10
Lithography	7nm
Transistor Count	10.3 billion
GPU Cores	2,304
Texture Units	144
ROPs	64
Core/Boost Clock	1,560/1,750MHz
Memory Capacity & Type	6GB GDDR6
Memory Speed	14GT/s
Memory Bus	192-bit
TDP	180
Display Connectors	DisplayPort 1.4, HDMI 2.0

Alienware Aurora R9

Its structural perfection is matched only by its hostility

WHEN WE FIRST SAW the new Aurora R9, we couldn't help but be impressed by its styling; but without any sense of scale from those first shots, we envisioned that it was much smaller than it actually is. Knowing it uses a microATX motherboard didn't help. Essentially, this is a much bigger chassis than you might think. And had it been closer to the likes of the Corsair One in terms of size, we'd be much more eager to reach for our credit cards. But we're getting ahead of ourselves—there's still a lot to admire here.

The design is clean and bold, sitting somewhere between an air conditioning unit and a modern console. The light and dark color scheme works well, with the accented lighting loop on the fascia making for a striking-looking PC. The left-hand side panel and top have hexagonal vents cut out to aid airflow, but the Aurora R9 bucks the trend of having glass panels to show off the innards. A brave move, but one that works. This is an understated system. Quite the departure for Alienware. So, it's a shame the back of the machine is an ugly industrial panel—although, to be fair, you'll rarely be peering at that once you've set it up.

Things get interesting when you open it up. You need a screwdriver to release the single screw holding the catch on the back, but once that's out the way, the rest is pretty much tool-free. Release two more catches on the back, and the internal side panel that houses the PSU swings out to afford access to the smartly laid-out interior. There are empty bays for drives, space for two more memory sticks, and room for another graphics card. All easily accessible, and with the necessary cables awaiting such upgrades.

Dell has elected to use an all-in-one solution for cooling the CPU, and while it's only connected to a single-fan radiator, it does a good job of keeping the Core i7-7900K found in our model cool (66 C in testing). A front intake fan maintains good airflow over the GeForce RTX 2070 Super graphics card and hard drive, and it also means that having the PSU over the processor isn't a problem. Those fans do make a fair amount of noise under load, though, and maybe a twin-fan radiator would have been a better move.

As we've mentioned, the model we're reviewing packs a GeForce RTX 2070 Super, which means that you'll experience flawless performance at 1080p and 1440p at the top presets. 4K starts to put a strain on its capabilities, but dial down the post-processing a little, and you should be looking at smooth frame rates. Even so, at ultra settings at 4K, you're looking at a reasonable 38fps in both *Total War: Warhammer II* and *Tom Clancy's The Division 2*, while *Metro Exodus* managed 41fps at high settings, although this dropped to 18fps at extreme, so it clearly pays to be selective with your effects.

It's at this point we come to the often thorny subject of value for money. If you were to piece a similar system together yourself, using off-the-shelf parts, you'd be looking at something in the region of $1,750. Which means you're paying Dell a small premium for the overall look and design of the Aurora R9, plus that tasty warranty, which is pretty impressive on its own. It's great value, in other words.

Alienware has had some hits and misses over the years, and while we're not totally smitten with all the design decisions here, overall it still definitely sits in the hit column. It's powerful where needed, looks good, has plenty of upgrade potential, and represents decent value for money. We'd have preferred the overall footprint to be smaller, and it can be a noisy operator, but if you're looking for a gaming machine that stands out from the crowd, this is definitely worth considering. **–ALAN DEXTER**

VERDICT 8

Alienware Aurora R9

BOREALIS Striking design; easy to upgrade; strong performance; good feature set.

OVERCAST Can be loud under heavy load; bulky chassis.

$1,880, www.dell.com

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	2,178	1,486 (-32%)
CrystalDisk QD32 Sequential Read (MB/s)	3,136	3,283 (5%)
CrystalDisk QD32 Sequential Write (MB/s)	2,126	2,956 (39%)
3DMark: Fire Strike Ultra (Index)	6,988	5,951 (-15%)
Total War: Warhammer II (fps)	42	38 (-10%)
Tom Clancy's The Division 2 (fps)	38	38 (0%)
Metro Exodus (fps)	37	41 (11%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an Intel Core i9-7900X, 32GB G.Skill RipJaws V series DDR4 @ 3,000, an MSI GeForce GTX 1080 Ti Gaming X, and a 512GB Samsung 960 Pro PCIe SSD. All tests performed at 4K at the highest graphical profile. *Metro Exodus* tested using high settings.

SPECIFICATIONS

Processor	Intel Core i7-9700K
Graphics	Nvidia GeForce RTX 2070 Super 8GB
RAM	16GB HyperX Fury DDR4-2933
Motherboard	MicroATX Z370 Express
Storage	1TB M.2 PCIe NVMe SSD (boot) + 2TB 7,200rpm HDD
Cooling Solution	Alienware all-in-one 120mm
PSU	Alienware 850W multi-GPU approved
Case	Alienware Aurora R9
Warranty	One-year hardware with onsite/in-home service after remote diagnosis

For a microATX machine, it's bigger than you'd think.

Dell XPS 13 2-in-1

Dell makes its flagship foldable even better

THE XPS 13 was already pretty good, especially since the minor redesign that saw Dell return the webcam to its rightful place in the center above the screen. But then came the hardware refresh—more powerful components, chiefly the Intel Core i7-1065G7 processor that has cropped up in a number of ultralight laptops as of late.

If you've been following Intel's latest, you'll know why this is kind of a big deal; if not, we'll give you the CliffsNotes. The 10th generation of Intel's mobile CPUs are equipped with new integrated graphics, namely Iris Plus, a new breed of on-chip graphics that blows previous iterations out of the water. This is huge for superslim devices—removing the need for discrete graphics cards means that notebooks and tablets can be thinner and lighter than ever before.

And so we arrive at the new XPS 13 2-in-1. Yes, that's its actual name—apparently, consumers need to be told that a product is both a laptop and a tablet right from the get-go. But this convertible does do a great job of being both devices, with a gorgeous 4K touchscreen for tablet tasks and a solid keyboard for typing in laptop mode.

Let's talk about that screen first. It's bright, colorful, and boasts incredible sharpness for such a small screen. This 2-in-1 doesn't come with a stylus, so you're limited to finger controls, unless you splash out on an active stylus; if you use the tablet mode regularly, you will also probably want to invest in a microfiber cloth to keep that screen fingerprint-free.

With regard to the rest of the design, Dell hasn't pulled any punches. The aluminum casing and tiny screen bezel scream "high quality," and the overall build feels exceptionally sturdy, right down to the trackpad and rounded metal USB-C ports. The keyboard is good, too; a little more travel on the keys would be nice, but this keyboard isn't truncated like some other notebooks.

XPS-ENSIVE XPS-ERIENCE

There isn't much else to say about the physical design; some security features, such as a fingerprint scanner or webcam kill switch, would have been nice, but aren't mandatory inclusions. The XPS isn't cheap, though, with model prices all sitting around 2,000 bucks. Our model—with 16GB of RAM and a black interior finish—is the cheapest, at $1,760.

For that price, you need quality in performance as well as in design. Luckily for the XPS 13 2-in-1, that Intel processor carries it to victory, letting it hold its own against other ultralight laptops. Iris Plus graphics are leaps and bounds beyond last-gen graphical capabilities, and 16GB of high-speed memory is perfectly sufficient for most conventional notebook tasks. A 32GB model is available, but we'd only recommend that if you use RAM-intensive software regularly.

Gaming isn't really an option, at least beyond a spot of casual *Fortnite* at lower graphical settings. Dropping the resolution to 720p is often necessary, and the latest triple-A titles are definitely beyond the XPS 13's reach. Rendering is well handled, although this isn't a powerhouse machine; graphical artists will love the tablet mode, but high-end 3D rendering tasks are better suited to bulkier machines.

The only thing we wish the XPS 13 2-in-1 had is more ports. All you get is two USB-C ports, a headphone jack, and a microSD card reader; sacrifices made to ensure the superslender form factor, we imagine. A USB-A port would be appreciated to circumvent the need for adapters and USB hubs; the lack of a dedicated AC power connector also means your USB-C ports are cut down to one while the laptop is plugged.

These don't ruin the system, though; this convertible XPS is as good as they come for the price. The battery life is fine; drive transfer speeds are a bit below what we'd hoped for, but the difference will be imperceptible for the majority of users. If you're looking for a simple but effective 2-in-1, you could do a lot worse than Dell's latest offering. **–CHRISTIAN GUYTON**

VERDICT 8

Dell XPS 13 2-in-1

RAISE Incredible display; sleek design; good keyboard; Iris Plus is still great.

FOLD No USB-A ports; not great for gaming; drive performance a smidge low.

$1,760, www.dell.com

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	561	721 (29%)
CrystalDisk QD32 Sequential Read (MB/s)	3,100	2,379 (-23%)
CrystalDisk QD32 Sequential Write (MB/s)	557	1,262 (127%)
3DMark: Fire Strike (Index)	1,062	2,906 (174%)
Rise of the Tomb Raider (fps)	5	12 (140%)
PCMark 8 (Index)	2,543	3,621 (42%)
Battery Life: Movie Playback (Minutes)	840	760 (-10%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our notebook zero-point is the HP Spectre X360, with an Intel Core i7-8565U, integrated Intel UHD Graphics 620, and 8GB of DDR4-2400. *Rise of the Tomb Raider* is tested at 1080p at the highest graphical profile.

SPECIFICATIONS

Processor	Intel Core i7-1065G7
Graphics	Intel Iris Plus
RAM	16GB LPDDR4X-3733
Screen	13.4-inch UHD+ WLED (3840x2400)
Storage	512GB PCIe NVMe x4 SSD
Keyboard	Island-style backlit
Battery	Four-cell 51Wh
PSU	45W AC adapter
Weight	6.05lb
OS	Windows 10 Home 64-bit

The patterned finish on the inside is surprisingly comfortable in lengthy typing sessions.

MSI Prestige PS341WU

When 4K is not quite enough...

AS FIRST WORLD PROBLEMS GO, the fact that it's hard to find a PC monitor with more than eight million pixels has got to be up there. But if you want a truly high density display, your options are limited.

Yes, you can choose from a huge array of 4K UHD monitors, but 4K doesn't automatically equal high DPI. Take a typical 32-inch 4K screen. That works out at 138 pixels per inch, not much higher than the circa 100 dpi that most flat panel monitors have offered for years.

As ever, a relevant but not entirely empirical yardstick involves Apple and its Retina displays for Macs. Apple has decided on a minimum of around 200 dpi for its portable and desktop systems, including the new Pro Display XDR, thus far higher than nearly all PC monitors.

You can, of course, achieve higher pixel density with the same resolution via a smaller panel. A 24-inch 4K monitor clocks in at a decent 184 dpi. But who wants to pay big bucks for a mere 24-inch monitor? Enter, at last, the MSI Prestige PS341WU. Its main claim to fame? A native resolution of 5120x2160, also known as 5K2K. That's three million more than the 3840x2160 4K pixel grid.

Applied to the PS341WU's 34-inch ultrawide panel, the result is 163 pixels per inch. Not quite Apple Retina standard, then, but a big upgrade compared to larger format 4K monitors. Of course, pixel density isn't the only thing this MSI monitor has going for it, which is just as well, given the premium price of around $1,200. You also get a very high fidelity Nano IPS panel from LG. MSI claims static contrast of 1,200 to one, but the PS341WU also supports VESA DisplayHDR 600, which requires local dimming.

As it turns out, the PS341WU's local dimming tech is about as rudimentary as it gets, with just 12 zones. But you do at least get support for HDR content, even if the specs suggest you can't expect a true HDR experience. In practice, that's pretty much how it plays out. The HDR support is more of interest from a content creation perspective than content consumption.

But that's OK, given the overall image quality on offer, which is pretty special. The Nano IPS is gorgeous. It's so vibrant, but so natural. The contrast and viewing angles are great, too, and MSI's default calibration is nicely executed. MSI has also included calibrated presets for the sRGB, Adobe RGB, and PCI-P3 color spaces, which is handy even if you'll still want to manually calibrate for really serious workflows. Oh, and for the record, MSI claims the Prestige PS341WU achieves 100 percent coverage of the sRGB gamut and 98 percent of DCI-P3.

Add the tight pixel pitch to the luscious panel quality and you have a feast for the eyes. This is also a flexible, user-friendly monitor, primarily thanks to the USB-C interface with support for charging. Once you've gone to single-cable USB-C, especially if you drive a laptop PC, you won't want to go back to multiple cables.

So, the MSI Prestige PS341WU is an all-around winner, then? Not quite. Size is part of the problem. At this price, 34 inches feels stingy. Build quality and styling are also issues. Some of the plastics used in the chassis are not befitting of a premium monitor. The same goes for the stand's cheap, sprayed base.

Styling is a subjective issue, of course, but the overall aesthetic is an odd mix of professional and gaming cues. MSI is, perhaps, not quite in its comfort zone operating in the pro display market, and it may take a few iterations to find its form. In the meantime, the Prestige PS341WU is a very fine display in need of just a little productization polish. **–JEREMY LAIRD**

VERDICT **8**

MSI Prestige PS341WU

GOLD STANDARD Higher DPI than most monitors; gorgeous IPS panel.

BASE METAL Pricey; patchy build quality.

$1,210, www.msi.com

SPECIFICATIONS

Panel Size	34-inch ultrawide
Panel Type	IPS
Resolution	5120x2160
Pixel Pitch	163 dpi
Brightness	600cd/m^2
Contrast	1,200:1
Pixel Response	6ms
Refresh Rate	60Hz
VESA Mount	100 x 100mm
Inputs	DisplayPort, HDMI, USB-C

Welcome to the brave new world of 5K2K.

Enermax Liqmax III ARGB 360

Cooling in color at a bargain price

WHEN WE LOOKED UP the Liqmax III ARGB 360, we found that it was the cheapest three-fan AIO cooler on Newegg.com. And its competitors lack flashy lighting. One hundred bucks for a cooler setup packing a 360mm radiator, with ARGB fans, and a light-up pump block? Incredible.

A low price like that can be enticing, but it also made us nervous. Could we expect good performance from such a cheap AIO cooler? A few hours of testing and we had our answer: Yes, we really could.

Compared to a stock AMD cooler, the Liqmax III performed incredibly. Nothing pushed the Ryzen 7 2700 in our test bench over 60 C during testing, even while overclocked to its max boost clock of 4.1GHz. The stock Wraith Spire that comes with the CPU broke 60 C at 3.2GHz, reaching 81 C when overclocked.

No matter how hard we thrashed the processor, we couldn't get it anywhere close to overheating. It didn't perform quite as well as more expensive 360mm AIO coolers—with temps averaging 4 C higher than a triple-fan Corsair Hydro, priced at nearly double the Liqmax III—but it's fantastic value for money if you're only interested in performance.

It's not as aesthetically pleasing as more expensive coolers—the fans do look cheap out of the box, although they light up nicely once they're running, and the pump block has a ring of LED lighting as well. It's quite gentle, not the bright RGB of Corsair and Cooler Master AIOs, but they shine through tinted glass perfectly well. We do wish the light-up logo on the pump wasn't so prominent, but Enermax isn't the only manufacturer guilty of that.

Controlling the lighting isn't as easy as we'd like; while daisy-chaining those fans together to synchronize them isn't hard, getting our ROG Strix board to manage the lighting took ages. The included physical controller does work well, though, allowing for a good amount of manual customization, but it requires an additional accessory power connector.

The pump block has a better internal design than its cubic exterior suggests, too. Enermax's patented dual-chamber design separates the pump from the heat plate to keep internal temperatures low enough to extend the pump's lifetime. We imagine that the fans are always more likely to give up the ghost before the pump when it comes to AIO units, but it's still a smart bit of design. The weaved tubing

feels just as high-quality as any premium AIO cooler, as does all the cabling from the fans and pump. The long radiator isn't quite as robust in terms of build quality, but it's hardly noticeable.

Compatibility is a sticking point. It fits standard AMD and Intel CPUs, but it doesn't support Threadripper chips, and the overall setup took a while. Where other manufacturers have designed pumps that work with existing stock brackets, Enermax's solution involves numerous screws, springs, and washers.

An AIO cooler that can match the Liqmax III for value won't be easy to find. It is worth noting that 360mm of radiator space will be excessive for many builds, especially if you don't overclock your CPU. If you like to boost your processor, though, or you're building a big powerhouse PC, there's now no need to spend hundreds on a cooler. **–CHRISTIAN GUYTON**

BENCHMARKS

	Enermax Liqmax III ARGB 360	AMD Wraith Spire
Idle CPU Temperature (C)	**25**	31
Prime 95 @ Stock (C)	**44**	63
Cinebench R15 @ Stock (C)	**41**	52
Ghost Recon: Wildlands @ Stock (C)	**42**	54
Prime95 @ 4.1GHz (C)	**58**	81
Cinebench R15 @ 4.1GHz (C)	**57**	74
Ghost Recon: Wildlands @ 4.1GHz (C)	**49**	68

Best scores are in bold. Our test bed consists of a Ryzen 7 2700, 32GB of Corsair Vengeance RGB Pro DDR4-3200, a ROG Strix X470-F Gaming, Nvidia GeForce GTX 1080, Adata SU630 SSD, and a Be Quiet! Dark Power Pro 1200W PSU.

VERDICT **9**

Enermax Liqmax III ARGB 360

MAXIMUM Exceptional value; good performance; quiet fans.

MINIMUM Installation is awkward; looks a little cheap.

$100, http://enermaxusa.com

SPECIFICATIONS

Socket Compatibility	LGA1150, LGA1151, LGA1155, LGA1156, LGA1366, LGA2011, LGA2011-3, LGA2066, AM2, AM2+, AM3, AM3+, FM1, FM2, FM2+, AM4
Radiator Size	360mm
Radiator Dimensions	15.5 x 4.7 x 1.1 inches
Cold Plate Material	Copper
Fan Airflow	72.1cfm
Fan Noise	27dBA
Warranty	Two years

The three fans provide good airflow without being too noisy.

BitFenix Nova Mesh TG 4ARGB

BitFenix brightens up its best budget case

THE NOVA and Enso lines from BitFenix were already solid cases with sensible price points, so we were understandably encouraged by the sight of a redesign with additional ARGB lighting. The Nova Mesh TG 4ARGB packs four ARGB fans, hence the somewhat obvious name, and the inclusion of tempered glass makes this feel like a quality case, despite the reasonably low price tag.

If you're familiar with the original Nova Mesh, this review won't be revelational. The standard tempered glass model checks in at $75, while this version costs $90; an extra 15 bucks for four of BitFenix's own 120mm addressable RGB Spectre fans, one in the back and three in the front. It's exceptionally good value, considering that a single decent ARGB fan is likely to cost at least that much if you buy it separately.

The fans run relatively quietly, and the triple stack behind the case's metal mesh front panel does a good job of pulling in air. The lack of any sort of RGB controller (or a PWM fan hub) is a shame, but unsurprising in a budget case. The little accessories bag just contains spare screws and stand-offs, and a plug-in speaker for whatever motherboard you use. Daisy-chaining the fans together for direct motherboard control is easy enough, of course.

Looking more broadly at the Nova Mesh TG 4ARGB's construction quality, it manages to impress in some areas and disappoint in others. The tempered glass panel feels great, as do the metallic mesh front and steel exterior. Inside the case, though, the PSU shroud and motherboard plate feel rather flimsy, and the frame is beset with numerous ugly exposed screw points. The stand-offs also came configured for an ITX board rather than the more common ATX layout, which was mildly frustrating.

The presence of a PSU shroud is still appreciated in a cheaper case, and it also conceals two bays for 3.5-inch HDDs. The plastic brackets can also house 2.5-inch SATA drives, allowing for a maximum of five with other mounting points. It's a rather odd combination, with two fixed mounting points and one removable panel mount.

Building inside this case was a somewhat mixed bag. Fitting a bulky motherboard required the removal of the rear fan during installation, and the rear I/O cavity has an odd curled metal edge that made fitting the motherboard's I/O shield quite tricky. The front cover is a struggle to remove due to its plastic pop-pin clasps.

CABLE GUISE

Besides these few niggling issues, though, the Nova Mesh TG 4ARGB is pretty easy to build in. It's a simple case, really; an instantly familiar mid-tower format that guarantees a straightforward build process for anyone with the slightest bit of system-building know-how. There's ample room for cable management behind the motherboard plate, and plenty of holes to feed through cables; two are fitted with rubber covers to keep things neat. Our finished review build looked clean, and the white color scheme of our review unit matched up great with white components.

The budget nature of this case means there are disappointing elements that could be avoided in a more premium chassis. The front I/O's exposed silicon inside the case looks pretty bad, and the I/O itself is a bit lacking, supporting only two USB-A 3.0 connections and two 3.5mm audio in/out jacks. The power and reset buttons are large and have a satisfying click to them.

No USB-C support on a modern case is a significant blind spot, although in the Nova's defence, finding a case with both that and multiple ARGB fans for under 100 dollars isn't easy. In fact, this is one of the cheapest cases with proper addressable fan lighting available right now—at least, without venturing into the murky waters of lesser-known budget brands. It's not perfect, but if you're looking to make a colorful setup without breaking the bank, BitFenix's latest is the way to go. **–CHRISTIAN GUYTON**

VERDICT 8

BitFenix Nova Mesh TG 4ARGB

SUPER NOVA Great value; good ARGB fans; easy to build in.

BLACK HOLE Cheap internal design; no USB-C support; interior is a bit ugly.

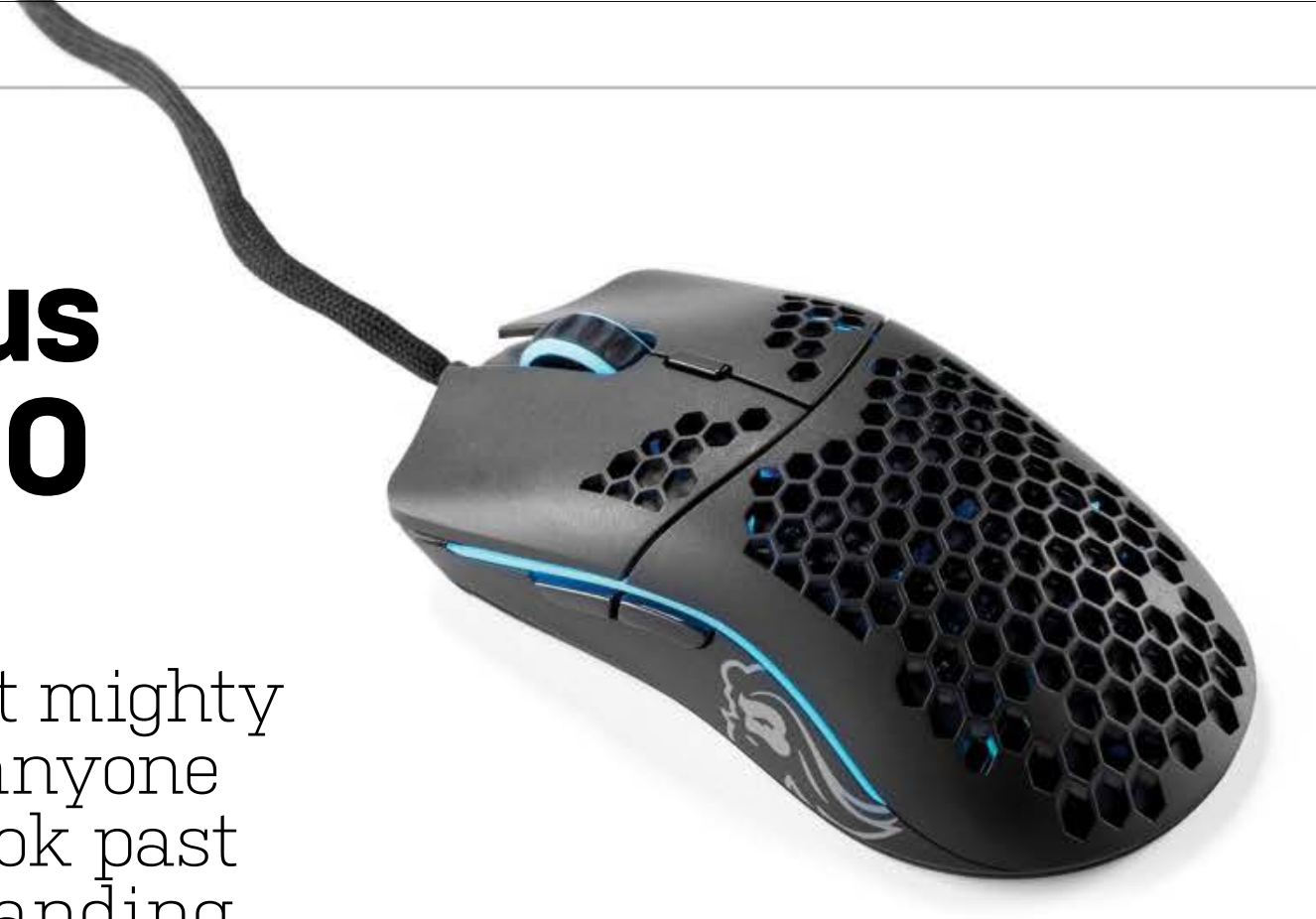
$90, http://bitfenix.com

SPECIFICATIONS

Format	Mid-tower
Motherboard Support	ATX, E-ATX, mATX, ITX
Colors Available	Black, white
Window Available	Yes
3.5-Inch Support	2
2.5-Inch Support	3+2
Radiator Support	360mm front, 240mm roof, 120mm rear
Fan Support	3x 120mm front, 2x 120mm roof, 1x 120mm rear
Dimensions	8.1 x 18.1 x 17.2 inches
Graphics Card Clearance	13.3 inches

Glorious Model O Minus

A small but mighty mouse for anyone who can look past the silly branding



THERE ARE ONLY two things we would change about this fantastically light gliding Intellimouse-style model from Glorious. The first is the placement of its DPI indicator light, which is useless on the underside of the mouse if you need to check it while you're actually playing a game, and could be easily remedied by relocating it somewhere—anywhere—on top. The other is the Glorious branding itself.

Look, it's a great peripheral maker. This mouse, its larger Model O variant, and the Model D are all built to a ludicrously high standard, and wouldn't raise an eyebrow if they were priced at double their current tag. But there's something about taking inspiration from *that* subreddit—the Glorious PC Gaming Master Race—that just makes your toes curl. What we wouldn't give for a blackout version without that bearded man on the left-hand panel.

But let's focus on the good, because the good comprises almost the entirety of this $50 mouse. A Pixart PWM 3360 optical sensor sits at the heart of the Model O Minus, offering up to 12,000 dpi and four preset sensitivity settings, which can be tweaked via the imaginatively named Glorious Model O Software. This is the public version of Logitech's 3366 sensor, and it performs beautifully within a lightweight chassis like this.

The body is built around a skeletal frame concept, with weight-saving hexagonal perforations running across the entire underside of the mouse and most of the top, including the back third of LMB and RMB. The result is a sprightly 2oz total weight (not including the cable), which makes it the lightest on the market. A simple six-button layout rounds off the features, with smartly placed forward/back web navigation buttons above your thumb—if you're right-handed, of course—and a DPI mode button below the mousewheel.

BUTTON HOLES

There is some slight lateral movement on the left and right mouse buttons above the Omron mechanical switches, which some users have reported as detrimental to their play, and sure enough, if you consciously waggle the button, you'll get some movement. Frankly, though, it simply never became a noticeable issue during normal play throughout our testing period. And that period included a lot of *CS:GO*. More than was strictly necessary, actually, but such is the joy of gliding around with the Model O Minus underhand that it's easy to get carried away. The Intellimouse shape has always been a favorite under this writer's hand, who'd previously favored much weightier designs, even using those additional weights that come with some mice. The lithe, precise feeling this produces is a game-changer. It doesn't make you a better player right away, not unless you've been using a 1990 trackball mouse up to this point, but it eliminates any chance of blaming your hardware.

The Model O software allows for an additional two DPI presets along with the four you get by default, and also lets you set each of these just how you need them. As there's no dedicated sniper/low DPI button, you can MacGyver your own with the software by using just two presets, setting one to your regular DPI and the other to a super-low sniper mode.

It's worth noting that the Model O is available in eight different variants: firstly the full-size 2.4oz model or this smaller, lighter Model O Minus, and each iteration comes in either black, white, matte, or gloss finishes. The matte black is aesthetically the pick of the bunch, and can be dialed down to a relatively subtle look by turning off the RGB in the software or setting it to a single color.

The Glorious Model O Minus is this reviewer's new mainstay for competitive FPS play, dislodging the Alienware AW959 from pride of place. Anyone with a lot of love for twitch-shooters, battle royales, or anything else that gets you thinking seriously about your DPI should consider doing the same. It really is that good. **–PHIL IWANIUK**

VERDICT 9 KICK ASS!

Glorious Model O Minus

+ MODEL CITIZEN Super lightweight; brilliant build quality; feels amazing.

– O NO DPI indicator is on the underside.

$50, http://pcgamingrace.com

SPECIFICATIONS

Sensor	Optical
Sensitivity	12,000 dpi
Sensor Model	Pixart PMW-3360
Polling Rate	1,000Hz (1ms)
Programmable Buttons	6
LEDs	3 RGB zones
Cable Length	6.5 feet
Weight	2oz

Asus TUF Gaming H7 Wireless

When the going gets TUF, are Asus's 53mm drivers up to the job?

THE HEADSET marketplace is pretty crowded. SteelSeries has had the wireless cans game cornered for the past few years with its Arctis line, but in turn that product's popularity has probably, dislodged any misgivings gamers had about going wireless. Won't there be latency? Do they have a high noise floor? Will I hear passing truck drivers chatting on their CB radios? Thanks to the Arctis headsets, these old wives' tales of wireless are no more, and everyone's looking to ditch a cable or two.

The result is a breadth of options in 2020 that's so voluminous you could lose days to researching and weighing up your options. But this TUF Gaming H7, from a manufacturer much better known for its components than its peripherals, is a real contender. It's comfortable, well presented, and thanks to a set of huge 53mm drivers, pretty powerful, too.

The H7s feature a completely different design from other headsets in the Asus fold, adopting a floating headband design that uses lightweight plastic surrounded by a cushioned and elasticated exterior below the skeleton of the headset itself, which is made from black brushed aluminum. The idea behind it is obviously to keep as much of the 14oz total weight off the top of your head, either through clamping force in the earcups or the stretchy headband. And it works, too, bolstered by generous cushioning around the earcups and a very soft breathable fabric surrounding it. Despite weighing in at the heavier end of the market's spectrum, these don't dig in over time or give you the ear sweats.

The interface is all located at the rear of the left-hand earcup, and it's standard stuff: a volume scroll wheel at the top, then a mute switch, and a power button at the base. All are easily located and operated while wearing the H7s, so points to Asus there. At the very bottom of the cup is a micro-USB socket for charging (the battery life's a respectable 15 hours, so you'll only need to hook this up every couple of days), and further toward the front is the input for the detachable mic. The mic itself is easy to position and stays where you put it, providing reasonable noise cancelation when the mechanical keyboard gets a-clickin'. It's not the fullest sound we've tested lately, but there's very little noise floor, and you'll certainly be heard loud and clear over Discord.

Use Asus's Armory software, though, and you can get the mic sounding much better, up there with the clearest and most full-bodied on the market. And, frankly, you'll need to use Armory, because the H7s come with virtual surround enabled by default. A trip into the software is required to switch back to the far superior and more usable stereo output. This isn't a deal-breaker, obviously, but it is an annoyance, because Armory is quite bulky compared to other peripheral tweaking programs. And in an ideal world, you'd be able to use a headset without the need for any software at all, wouldn't you?

And what about those monstrous drivers? Well, in a few specific scenarios, they sound great. Action games, shooters, RPGs—anything in which things are likely to combust with any frequency, really. The sheer heft of the bass response really sells these moments. However, the H7s don't clean up quite well enough for the more delicate moments. The walk through the mystic glade in said RPG. The contemplative "We were just following orders" moment in shooters. Here, the bass tends to color the overall sound a bit too warm and loose, lacking articulation higher up the EQ register. Not to a disastrous degree, by any means, but it's a more limited sound than—yes—SteelSeries's Arctis 7s offer.

There's plenty to like, then: great build, great comfort, and great sound in the more bombastic titles in your collection. It's just held back a little by low-end gorging, and an odd call to enable virtual surround by default. **–PHIL IWANIUK**

VERDICT **7**

Asus TUF Gaming H7 Wireless

TUF LOVE Comfy floating headband design; brings the battlefield to you.

H-BOMBED Too bassy; virtual surround enabled by default.

$140, www.asus.com

SPECIFICATIONS

Frequency Response	20Hz–20kHz
Impedance	32 ohms
Design Style	Closed-back
Drivers	53mm neodymium magnet
Microphone	Unidirectional electret condenser
Battery Life	15 hours
Weight	14oz

Audio-Technica AT2020 USB+

Can a studio stalwart dislodge the nu-school streamer mics?

AUDIO-TECHNICA'S got skin in the game when it comes to studio recording. If the Blue Yeti, Razer Seiren, et al are the young upstarts, the modern mic equivalents of The 1975 and Another Sky, Audio-Technica is Beethoven. There's no doubt the Japanese manufacturer can develop—and has done so many times—a better microphone than currently exists on the gaming market. The question is whether it can gather all that expertise, carry over the pro audio-grade build and sound quality, and package it together into an affordable USB mic.

The AT2020 USB+ represents the company's second stab at this feat. The original AT2020 took an existing low-price studio mic and simply swapped an XLR for a USB input for ease of setup. This time, the AT2020 USB+ enjoys an expanded frequency response range of 20Hz–20KHz (the range of human hearing and not a cent more), along with a desktop stand, carry case, and 10-foot-long USB cable.

Designed to plug in and start doing its job with minimal fuss, this is a simple mic on the spec sheet. Just one cardioid polar pattern, one mic monitoring input with a volume scroll, and an overall gain scroll. Along with the USB input itself, that's it for the mic's ins and outs. That simplicity is mirrored in the visual presentation—no-nonsense gunmetal finish, simple branding below the diaphragm, and a few white icons.

With all that said, it's an attractive look that conveys Audio-Technica's studio heritage. The metal capsule itself is satisfyingly heavy and will withstand some heavy knocks without taking damage, and while we wouldn't recommend dropping it on to a hard floor, it looks as though it would stand at least a fighting chance if it came to it.

Despite the minimal options here—one polar pattern, 20Hz–20KHz frequency response, 44.1KHz/16-bit sample and bitrate recording—the AT2020 USB+ sounds great. There's a clarity to the high end, noticeable in sibilant consonants when you're recording speech and in the higher strings on a guitar, which sounds much more expensive than it is. While it's not the warmest sound out there in the streamer mic market—the Blue Yeti probably still has that accolade locked down—it's still full-bodied enough to give your Twitch streams a professional easy-on-the-ear audio quality, and to deploy in podcasting or music recording environments.

KEY NOTES

In fact, it might even be better suited to music than capturing conversation. The pickup pattern is fairly broad here, so the AT2020 USB+ pulls in a bit of room ambiance around the audio source. That's generally for the benefit of the recorded sound, but if you're clickety-clacking away on a keyboard just behind the mic, you'll hear some of those mechanical keys, too. It's only faintly more noticeable than on the absolute best USB mics we've tested—the Beyerdynamic Fox and the aforementioned Blue Yeti—but still worth flagging up.

Embrace it as a budget studio mic, though, and you'll get great vocals out of the AT2020 USB+ and especially sweet acoustic guitar recordings. The paradox here is that if you're primarily going for music recording, you'll probably already have an audio interface with XLR inputs, so this mic's super-convenient setup won't count for much. So, perhaps it's best to view this as a very competent jack of all trades, ready to convey your Twitch banter to the masses, and just as happy capturing your one-person album of acoustic Slipknot covers in its/your downtime. All together now: "I push my fingers into my...."

The desktop stand could be better, truth be told, and is easily tipped over, but when attached to a proper boom arm, this is a worth addition to any streaming setup and budget home studio. It doesn't offer the best outright sound quality, and anyone looking for that should check out the Beyerdynamic Fox, but it does offer a very happy medium. **–PHIL IWANIUK**

VERDICT **8**

Audio-Technica AT2020 USB+

INCREDIBLE TEKKERS Crisp highs; easy to set up; great build quality.

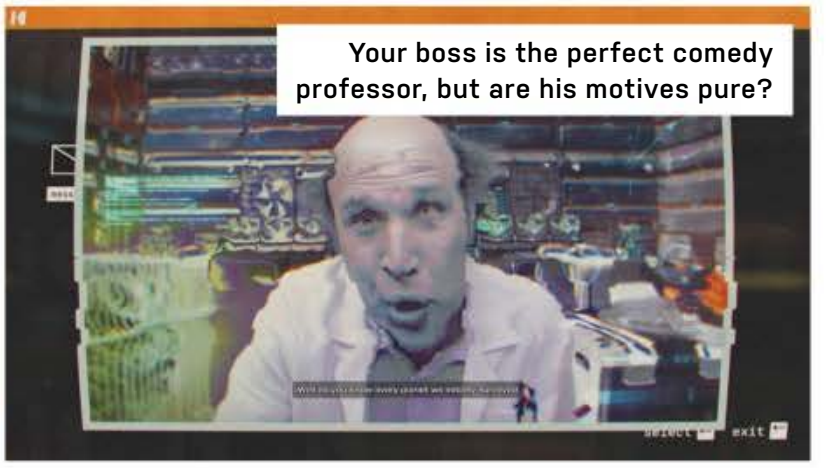
TECHNICAL FOUL Not totally perfect for streamers.

$120, http://audio-technica.com

SPECIFICATIONS

Frequency Response	20Hz–20kHz
Sample/Bitrate	44.1kHz/16-bit
Cable Length	10 feet
Polar Patterns	Cardioid
Element	Condenser
Power Consumption	48V, 2mA

ADVENTURE



Journey to the Savage Planet

In space, no one can hear you squee

AT FIRST, it doesn't seem so savage. Snowy, perhaps, as you teleport off your spaceship, supplied by the fourth-best interstellar exploration company, damaged and out of fuel. There's nothing to do but explore, and the first creatures you find are benign and amusing, especially once you work out how to make them fart carbon, an element you'll use for more than just getting a cheap laugh.

The world is beautiful and peaceful, a central mystery drawing you ever further from your ship as much as the need to survey the planet for potential human colonization, collect materials, and make repairs. It's not long before you can craft a simple pistol, and when you do first get attacked, it's more of a shock than a danger, the cute aggressors reduced to a pile of useful elements with a few shots.

Created by former members of the *Far Cry* and *Assassin's Creed* teams at Ubisoft, *Journey* feels much more like *No Man's Sky* than either of the Ubi games. It's nowhere near as expansive as that game, however, with everything you see hand-placed rather than procedurally generated. But the apple hasn't fallen that far from the tree, with objective markers being present and correct. Structurally, too, we've seen this before: You collect in order to craft (your ship has a 3D printer), and you craft in order to unlock new pathways for exploration. New areas offer new resources and new opportunities for crafting new things to create upgrades that open up.... You get the idea.

The game can be played in co-op, and there's a fully voiced AI companion to make sure solo players don't get lonely. The CEO of the company that sent you out makes appearances through comedic video messages, and they're a highlight of the game. Looking every inch the mad professor, his thirst for knowledge about what you discover is matched only by his relaxed attitude to your safety. Given that when you die you respawn in your spaceship, facing a trudge back to your corpse to reclaim equipment and collected elements, there's little penalty for overenthusiastic exploration.

Your boss isn't the only comedy element. All the farting and exploding into goo make this a world apparently built for entertainment as much as exploration. Your spaceship plays constant ads for dreadful products you have no hope of obtaining, and its computer—rattling along at 150MHz—is home to video messages from yet more sponsors. Scanning the flora and fauna gives you snippets of information about them, crisply written and short enough to have you looking for more. Actually, that phrase pretty much sums up the game. As a parody of capitalism, it's amusing, and you'll want to keep pressing onward through the less-than-linear six-hour runtime, but it fails to hit home with any weight as it's all so detached from the exploration and collection going on out in the cartoonishly colorful world.

That said, there's a great time to be had on AR-Y 26. Heading out and murdering the local wildlife is such a staple of videogames we're surprised it didn't get abandoned years ago, yet when combined with an eye for cutesy creature design and a witty turn with dialog, perhaps it's not so out of date after all. **–IAN EVENDEN**

VERDICT **8**

Journey to the Savage Planet

SAVAGE Cartoonish world to explore, with some satisfyingly funny moments.

SAUSAGE Lacks real savagery, much like many of the world's inhabitants.

RECOMMENDED SPECS Core i5-750; 4GB RAM; GeForce GTX 660/Radeon HD 7950.

$30, http://savageplanetgame.com, ESRB: T

© TYPHOON STUDIOS

That's about as far as you can zoom out, and battles never fill the screen.

REAL-TIME STRATEGY

Warcraft III Reforged

Strategy from the days before WoW

THERE HAS BEEN, it seems, a little controversy. *Warcraft III Reforged* was meant to be much more than a graphical update of an 18-year-old RTS. It was meant to bring things into line with the events of *World of Warcraft,* upgrade the world editor and UI, completely remaster the maps and campaigns, plus fully support 4K resolution.

Whether it succeeds by the time you read this, we couldn't say. At the time of writing, a patch had just arrived to fix some of the more egregious errors in Classic mode, such as loading into a mission only to be faced with the "Defeat" banner. It hasn't, however, returned the missing online leaderboards and clans. The opening cinematic has been remade, but the others haven't. The minimap is a pixelated mess. Hopefully, more patches are to come, as Blizzard is doing the right thing, albeit slowly.

If you're a veteran of the war between orcs and humans, there is, or should be, much to enjoy about *Reforged.* It does indeed run very nicely in 4K, although the viewpoint doesn't zoom out nearly far enough. This is probably a design choice, because you can only have 12 units selected at once, in order to make it a game about small units, small bases, and small skirmishes, but the urge to spin the mouse wheel back remains nonetheless. The new-look units are colorful and detailed, the wolf pelts of orc shamen now look much more realistic, while humans' cloaks fold naturally from their shoulders. There's a strange sort of scale effect, where units are much too large for the buildings they're meant to be constructing or entering, which reaches its peak with the watchtowers that appear like giant chess pieces littering the landscape, but it's a pleasing sort of aesthetic, even if it does look more like a cartoon than ever.

HERO WORSHIP

For many players, however, this will be their first brush with the RTS flavor of *Warcraft.* Forget the large-scale battles of *Total War* and the massed tank rushes of *StarCraft,* this is completely driven by heroes, with maybe a few backup units and vehicles. You can build units of specialized warriors and upgrade them before sending them off to raze the enemy village. You produce villagers who mine gold and lumber to create buildings to support your armies. Everything you've played in an RTS is here in *Warcraft III,* and while in 2002 it was the leader of the pack, today it feels familiar rather than behind the times.

That familiarity could work against it, especially with the problems at launch. Why get this when there are other RTSes out there that learned from *Warcraft* and built on its foundations? *Warcraft III* was the greatest RTS of all, and being able to play it again, with its new coat of paint, is almost a fresh experience as you rediscover the game you loved rather than wallow in nostalgia. If you've never played it, this is precisely the place to dive in, as we don't seem to be getting a *Warcraft IV.* Poised uncomfortably halfway between a remaster and a port, *Reforged* needs a few more patches to regain its old glories, but when it gets there, there will be nothing to touch it. **–IAN EVENDEN**

VERDICT **7**

Warcraft III Reforged

ORCS Reasonably priced update of one of the greatest RTSes ever made.

BORKS Still waiting for all 2002's features to make it into 2020.

RECOMMENDED SPECS i5-6400/Ryzen 7 1700X; 8GB RAM; GTX 960/R9 280X.

$30, http://playwarcraft3.com, ESRB: T

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LAB NOTES

ALAN DEXTER, EXECUTIVE EDITOR

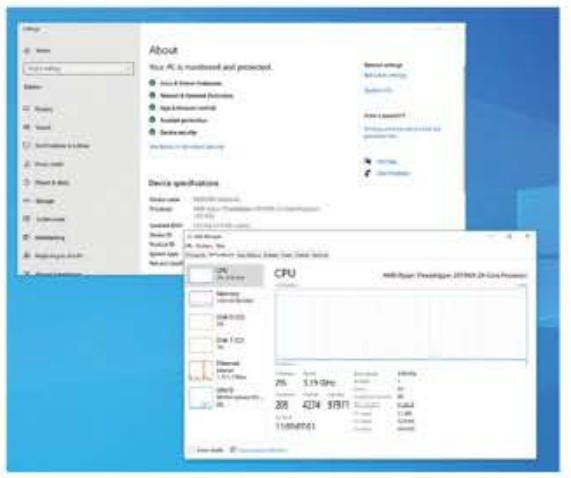
Moving with the Times

A lot has happened since I became editor, but it's time for a change

THIS IS MY LAST ISSUE editing *Maximum PC.* To think I've been at the helm for five years is incredible. It's flown by. Five years that have seen some of the most important advances in the PC's history, and we've covered them all within these very pages. From the rise of core counts, the shift to superfast NVMe SSDs, deep learning within reach of anyone with a notion to do so, dabblings in the virtual realm, and the introduction of real-time ray tracing—it's been a breathtaking few years, and it feels like there's plenty more to come.

Casting my mind back to the first issue I edited, the builds at the back of the magazine were notably different from what they are today. For starters, all the machines used Intel CPUs, while now AMD holds sway. Core counts were a fraction of what we have today (even the $2,800 Turbo build only had six cores, although with HyperThreading, that did equate to 12 threads), SSDs were tiny (256GB for the Mid-Range build), memory capacities limited (16GB was more than enough at the top end; 8GB was seen as plenty), and dual-graphics-card setups were still a viable path to extreme power (that Turbo build boasted a pair of GTX 980s at a total cost of $1,100).

While I'm a big fan of most of the changes we've seen over those five years (and yes, I'm still hopeful about the future of real-time ray tracing), probably the most important improvement has been on the software side. Back then, we were still rocking Windows 8.1, and boy is Windows 10 an improvement on that half-baked mess of an interface. Microsoft's latest OS hasn't been without its hiccups,



There have been some great advances in the last five years, but Win 10 stands out.

but it now works well for the vast majority of work, and has almost managed to make me forget its greatest OS of all time, Windows XP Professional. Almost.

JOANNA NELIUS

Hardware Staff Writer

I've spent a lot of time with Nvidia's cloud gaming service, GeForce Now, since it officially launched. It goes without saying that gaming on a local PC will always have lower latency, but GeForce Now is one of the best cloud gaming platforms—even if your maximum download bandwidth is 25Mb/s. It offers more granular controls than Google Stadia when it comes to resolution and frame rate. And overall, it's more reliable at lower bandwidths than Stadia, performing at under 25Mb/s without any lag, stutter, or rubberbanding. Of course, you have to sacrifice some image quality to keep a consistent 60fps, but it's only a problem under 15Mb/s; the graphics get so pixelated you can't see where you're going.

You also don't need to re-purchase games to play them. It works with your existing library on Steam, Epic, Origin, and so on. However, publishers such as Blizzard and Bethesda have been pulling games from GeForce Now, and if GeForce Now doesn't support a game, you can't play it on the service—which sucks for people who bought games from those publishers to play on Nvidia's cloud gaming platform. But if all you have is a Microsoft Surface and you want to play a game like *Borderlands,* or one of GeForce Now's other 100-plus games, it will turn your tablet into a decent gaming PC.

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Editors' Picks:
Digital Discoveries

Contributing editor, Zak Storey, and staff writer, Christian Guyton, have been shouting about things

GOOGLE HOME MINI

A lot's happened since I left these pages: I grew a beard, got a puppy, dabbled in the world of online, and now I'm back. Today, however, I'm talking about the little thing next to Maximum Doggo (below), the Google Home Mini. This weekend, it was a complete lifesaver.

My puppy has sadly been ill. She's been crate trained, which is fantastic, as it keeps her safe and makes her feel secure during stressful situations and at night, but when she's ill, it's a bit of a curse. Unfortunately, I awoke on Saturday morning to a very distressed, lethargic dog, with herself and her bed covered in her own diarrhea.

It's an assault on the senses and a lot to take in, first thing in the morning, when you're standing there in your underwear, but the price I happily pay to have a companion like her. I immediately let the dog out, getting myself covered in the unmentionable as I did so, put her in the backyard, and began shouting commands at Google: "Turn on the lights!" "When's the vet open?" "Broadcast: wake up!" "Call the vet!" "Play music!" Having the ability to do all that, alert my spouse, and distract myself while I cleaned up the awful mess was very much needed.

$40, https://store.google.com

WARFRAME: EMPYREAN

Just when I think Digital Extremes can't make *Warframe* any better, it does. What started as a procedurally-generated corridor shooter has evolved into something bigger and weirder, with over 40 playable "frames," dozens of environments, and hundreds of funky sci-fi weapons.

Adding hoverboards and massive open-world regions wasn't enough for the Canadian developer, as the latest major update sees players venturing into a whole new arena: co-operative space combat. With the *Empyrean* expansion, player clans in *Warframe* can now assemble a Railjack, a spaceship with a four-player crew, each with their own role on missions.

Space combat in games is nothing new, but *Warframe* has been around for almost seven years, making the Railjacks a huge addition to the already expansive roster of content. Perhaps the best thing is how well it works with the other elements—every Railjack has a person-sized cannon that allows you to board enemy ships, instantly switching to the game's familiar close-quarters combat. It's incredible how far the game has come, and I for one can't wait to see what Digital Extremes does next.

Free, www.warframe.com

© DIGITAL EXTREMES

iStorage cloudAshur

The hardware of the data protection field is better than ever, and iStorage is at the forefront, bringing straightforward, effective encryption solutions to the masses. We looked at the datAshur a few issues back; now, we're taking a look at the new cloudAshur, a hardware solution for protecting cloud-based storage.

The physical design echoes the company's previous datAshur devices, but with a sleek silver finish. It looks like a large USB flash drive with rubber control buttons for accessing the device. Unlike the datAshur, though, it functions less like a drive and more like a key, allowing users to access files in their cloud storage solution of choice, provided they have the correct PIN.

Data drawn down from the cloud by the USB module is encrypted both in transit and at rest, thanks to a hardware-based AES-XTS 256-bit encryption key stored on the physical device. Even hacking into a user's cloud account is ineffective without the encryption key. The five-factor authentication process makes breaking into the software from within a connected PC extremely difficult, too.

The ultra-secure design ethos extends to the casing, too. A hard epoxy coating protects the technology inside the brushed aluminum casing, rendering any attempts to physically break into the device hopeless; the epoxy resin cannot be removed without damaging the components. Finally, a metal sleeve protects the keypad and has a rubber seal to make the module effectively waterproof while inside. **–CG**

$129, https://istorage-uk.com/usa

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Ripping DVDs
> Component Bias
> Conversion Rates

Ripping Delights

I'd be interested to hear about Alan Dexter's project to rip all his DVDs to a NAS. In particular, the program and settings he used. Was he ripping the movie only or the entire DVD? I am looking at doing a project like this, but I am not sure of the best way to proceed.

–Wes Matthews

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: We've covered a few ways of doing this in these very pages, most recently in the December 2019 issue (Vol. 24, No. 12). I did rip some of the first DVDs using HandBrake, and the rips (just of the movies) were small (all less than 1GB) and looked reasonably good. The thing is, I have lots of space in the NAS I'm using, so size wasn't much of a problem, so instead I moved over to using DVD Decrypter, which worked with some of the discs that were erroring using HandBrake. So, that's what I've used for everything now. DVD Decrypter is free to download, and really is a single-button ripper for the most part. I haven't bothered with all the DVD extras, because if I want to explore those, I've still got the DVDs. It works well, though, and with Plex serving up the films from the NAS, it makes for a pretty interface, too.

Preferential Treatment

My last *Max PC* is in the mail, as they say. I'll try to eventually cover why.

1) For months and months and months, the three builds at back have featured Ryzen CPUs, AMD/Radeon GPUs, and more than a few WD drives. Let me put it this way. If you had a contest for a $10K PC with those components, and I actually won it, the next day after it arrived, it would be for sale. Intel CPUs, GeForce GPUs, and Seagate drives are all I use. I shouldn't write this, but my next Seagate drive that fails will be the first, both internal or external.

2) Don't remember seeing an article on how the only problem with this (my) PC is Windows 10 itself. Specifically, the updates. I get the updates. They are needed to protect your PC from invasion. How come Microsoft doesn't care that, twice in the last 12 months, its update has wiped out the sound on my PC. 320 million people in the country, and I'm the only one this happened to, right?

3) All the other builds on the inside are Ryzen, Ryzen, and more Ryzen. See #1 above.

4) This machine was a 2015 gaming build. It cost just south of 3K. Except for a misdiagnosis by my computer guru nephew (we bought a new mobo; it was the monitor), I have had no issues other than the Microsoft update-induced ones. That monitor was five or six years old, so no complaints there, and under $200. Not sure why you review monitors that cost as much as my entire system. I don't know anyone with a $2,999 monitor. Or even a $1,299 monitor. Not all your subscribers are PC experts, you know. I've had machines since the C64/Atari 800XL days, and I still know nuthin'. I like how many of your articles/fixes end with "that should resolve the problem." "That will resolve the problem" would be more reassuring.

I'll occasionally check at book stores for how long *Max PC* is Ryzen infected. If there is some sort of return to at least 50/50, maybe I'll be back. **–Burton Labelle**

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: Sticking with what you know is fine, but when markets change, and better options are available, you can miss out on better performance and deals if you do so. Obviously, it helps that the components you've known and loved have served you well, but plenty of readers will have similar experiences with different brands. To be honest, at this point in the tech industry's life, if a manufacturer made flaky hardware, it would go out of business pretty quickly. We're not saying that everyone left is perfect, but there's no obvious reason to discount a company like AMD just because you've always bought Nvidia and Intel. AMD has the lead at the moment, and it'd be remiss of us to not recommend it. The same goes for your preference of hard drive.

The Gift of Gaming

I'd like to echo Ms. Nelius's suggestion: I recently

↘ submit your questions to: comments@maximumpc.com

replaced my Maingear Rush with a Maingear F131. I couldn't bear to leave my faithful steed at a recycle center, so it's now on the desk of a friend from work's daughter, whose PC died. She's also a gamer and should get years of use from it. **–Dave Szatkowski**

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: We applaud your altruism, and hope others follow suit, but can we just take a moment to drool over your new rig? While we get plenty of systems through our hands, that's a very nice upgrade. But back on message: Yes, we should all gift our old machines, rather than throwing them into landfill.

Video Editor

I am a long-time subscriber since the magazine was called *boot*. I've built my own PC for years, and lately have gone with barebones models built for me to my specs. That said, I'm a little behind the curve on building the latest rigs, as I haven't had a great need to. Until now....

I need a more powerful rig for editing videos in DaVinci Resolve for my drone photography/cinematography business. I wondered if you could run an article on creating builds for video editing using Resolve. Three levels—budget, and so on—according to price and power, would be great.

–Christian Nommesen

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: We've got something planned along these lines in a few issues' time. Watch this space. Having a budget, mid-range and high-end build is a neat idea, though.

Conversion Therapy

In the Jan 2020 issue, on the Letters pages, Murray McCullough laments that a build priced at $590 costs $785 in Canada. He states, "A premium must be paid for a much smaller market. So sad!"

At the current exchange rate of 1.33 Canadian dollars for each US Dollar (as of February 2020), it seems Murray is paying the same relative cost as US shoppers, independent of market size. You could name almost any item price in US dollars and the price in Canadian dollars will be higher.

The Australian exchange rate is 1.50 Australian dollars per US dollar, so before shipping costs, that same $590 US build is $885 Australian dollars. Again, not based on market size, but exchange rate.

–Erik Goldoff

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: Exchange rates obviously play a part, but Murray didn't quote the Canadian pricing—he'd converted the prices back to US dollars after pricing it up in Canadian dollars. There are definite price differences around the world (in the UK, for example, components often have a one-to-one exchange rate, despite the GBP being worth $1.33).

As far as the Australian market is concerned, while some prices do adhere to a straight exchange rate conversion, have a look at something like the Asus ROG Strix RTX 2080Ti, and you'll see it doesn't quite add up—we found it for AU$2,278 from www.techbuy.com.au, as opposed to the $1,199 you'd expect to pay in the US. A tad more than the exchange rate would infer.

Streaming Futures

The old system was diskettes, followed by CD-ROMs, then downloads from Steam or GOG. The consoles followed suit. The new way, it seems, is going to be streaming. Which is where I see problems for the gaming industry.

We still have the GOG and Steam games, but my son likes the Xbox, where he can bounce around while playing. I like the PC. So, streaming is coming, I'm sure fraught with its own issues, but $120 a year is cheaper than two discs, especially with DLC.

Here's the problem: I can take those discs and trade them in toward the cost of another game. I can trade games with a friend, or buy a few used games at GameStop. I can wait for the price to come down before I buy a game. I have not seen this addressed in any article online or in print. **–David Loewy**

STAFF WRITER, CHRISTIAN GUYTON, RESPONDS: I agree that it's a concern. Online storefronts such as Steam have made the jump to digital games easier for many PC gamers, so a decline in second-hand game sales was inevitable before streaming even entered the picture. Console digital stores have also made much progress.

I'm not overly worried, though. People find a way to move with the times; when Netflix came along, people started sharing accounts with friends, rather than paying for multiple ones. Small acts of technological rebellion like this will almost certainly exist on game-streaming platforms.

Plus, game trade-ins aren't great value. Online sales (particularly the Steam Summer Sales) are frequently fantastic; if I can download a game on sale for five bucks, why would I choose that over buying a hard copy for 40? Particularly when I can only trade it in for 20.

Streaming isn't going to replace online storefronts, at least, not for a long time. Second-hand game sales are declining, but that's been happening for longer than platforms like Stadia and GeForce Now have been around. It's up to the consumer to find the best-value solution for them.

[NOW ONLINE]

DOES LIGHTING AFFECT FPS ON WEBCAMS?

Lighting affects webcam videography in a similar way as it affects photography. Things such as exposure time and shutter speed need to be taken into account, but unlike photography, or even traditional videography, we don't have the same manual control over those settings as we do with a professional camera. That's what makes lighting so important when filming something with our webcams, even if we prefer to keep our rooms dimly lit from the glow of our PC (assuming you are all about that RGB).

Read the full article: https://bit.ly/2I2aNGt

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THE BUILDS

BUDGET

INGREDIENTS

PART		PRICE
Case	BitFenix Nova TG	$65
PSU	EVGA 400N1 400W NEW	$38
Mobo	ASRock Fatal1ty B450 Gaming K4 NEW	$95
CPU	AMD Ryzen 5 2600	$132
GPU	Asus GeForce GTX 1660 SUPER Overclocked 6GB Phoenix Edition NEW	$230
RAM	16GB (2x 8GB) GeIL Evo Potenza @ 3,000MT/s NEW	$65
SSD	120GB Adata SU650 SATA III	$26
HDD	1TB Western Digital RE3 WD1002FBYS	$27
OS	Ubuntu Desktop Linux 18.04.3 LTS 64-bit	$15

Approximate Price: $693

GIGABYTE'S B450 MOTHERBOARD is no longer on sale, so we're back to full-price mobos. A price rise here was unavoidable, so we've gone for ASRock's Fatal1ty, sticking with the B450 chipset. We also saw minor price rises elsewhere; the case, processor, memory, and hard drive all rose, only by a few dollars each, but enough to add up. We weren't able to keep that price low without a significant downgrade, so we've opted to steer into the skid, upgrading the memory to 16GB from 8GB to future-proof this build. We went for a slight speed reduction to avoid throwing too much on the price: GeIL's Evo Potenza memory fits the bill perfectly. Elsewhere, we swapped to EVGA's 400N1 PSU, and chose a 1660 Super GPU with superior clock speeds: Asus's factory-overclocked Phoenix Edition, which has a gaming mode clock of 1,800MHz, higher than the boost clock of the EVGA card it replaces.

MID-RANGE

INGREDIENTS

PART		PRICE
Case	Fractal Design Meshify C	$85
PSU	500W EVGA 500 BR 80+ Bronze	$45
Mobo	ASRock X570 Phantom Gaming 4 NEW	$144
CPU	AMD Ryzen 5 3600X	$215
Cooler	AMD Wraith Spire	N/A
GPU	XFX Radeon RX 5700 8GB	$330
RAM	16GB (2x 8GB) GeIL Evo Potenza @ 3,000MT/s NEW	$65
SSD	500GB Seagate FireCuda 520 M.2 PCIe SSD NEW	$115
HDD	1TB Western Digital RE3 WD1002FBYS	$27
OS	Windows 10 Home 64-bit OEM	$100

Approximate Price: $1,126

WE MADE THE SAME MEMORY ADJUSTMENT for this build as for the Budget system, although it was less of an upgrade and more of a price-balancing move. The 16GB Evo Potenza kit from GeIL is great value right now, and keeping the price down on this build was certainly challenging this month. With that in mind, a sale on the PCIe 4.0 Seagate FireCuda made it better value than the Sabrent Rocket we used last issue, so we switched back to Seagate's SSD. We also switched back to ASRock's X570 motherboard, due to a slight price rise on the Gigabyte X570 UD board—making any small saving this time around was a must. While we looked into shifting the processor and GPU to different options, ultimately it simply wasn't worth it; the XFX RX 5700 remains the best-value model of that card on the market, and the Ryzen 5 3600X is still on sale for a perfectly good price.

UPGRADE OF THE MONTH

16GB (2x 8GB) GEIL EVO POTENZA @ 3,000MT/S

It's truly incredible how much memory pricing has shifted over the last few years. The ability to buy 16 gigabytes of high-speed RAM for a mere 65 dollars might seem almost absurd to tech heads who have been building PCs for years; even more recent recruits to the system-building community have to admit that memory is in a very affordable place right now. GeIL's Evo Potenza memory is fantastic value, an ideal way to upgrade to the 16GB mark if you're still rocking a 4GB or 8GB system. 16GB will leave any system well equipped for the next generation of hardware and software, and now is a good time to make that leap.

$65, www.geil.com.tw

© GEIL

SABRENT'S 1TB MODEL of the Rocket SSD is mercifully still on sale, so we won't be swapping that out yet. The twin Seagate HDDs are still great value for money, and we're not upgrading to a third-gen Threadripper either; the 2950X provides amazing performance for the price, and an upgrade would make the overall cost of this build untenable. Even the cheapest third-gen Threadripper retails at more than double the current cost of the 2950X.

Sadly, the Enermax cooler we had previously is no longer on sale, and our options are limited when it comes to sTR4 socket compatibility. We've gone for a three-fan Fractal Design Celsius model to replace it, which ought to keep that giant CPU cool. We're also replacing the power supply to keep our price from rising too much, using EVGA's 850W PSU from the SuperNOVA line.

We've got other upgrades, too. The GPU has been swapped out again, also moving over to EVGA for its RTX 2080 Super model. Most 2080 Super GPUs would work fine in this build; if you're looking to assemble a Turbo PC, keep an eye on the sales. The last change we made was some new memory, a collaborative work between Team Group and Asus to produce the T-Force Vulcan TUF Gaming Alliance RAM series. Yes, it's a wordy honorific, but this is good hardware, combining Team Group's affordable approach to RAM with Asus's "TUF" rigorous testing and manufacturing ethos.

For more of our component recommendations, visit www.pcgamer.com/hardware/buying-guides/

INGREDIENTS

PART		PRICE
Case	NZXT H700i	$170
PSU	850W EVGA SuperNOVA 850 G+ 80+ GOLD **NEW**	$125
Mobo	Gigabyte X399 Aorus Pro	$315
CPU	AMD Threadripper 2950X	$700
Cooler	Fractal Design Celsius S36 Blackout 360mm **NEW**	$124
GPU	EVGA GeForce RTX 2080 Super Black Gaming 8GB **NEW**	$690
RAM	32GB (2x 16GB) Team T-Force Vulcan TUF Gaming Alliance @ 3,600MT/s **NEW**	$150
SSD	1TB Sabrent Rocket NVMe M.2 PCIe	$180
HDD	2x 3TB Seagate BarraCuda Compute	$160
OS	Windows 10 Home 64-bit OEM	$100
Approximate Price:		**$2,714**

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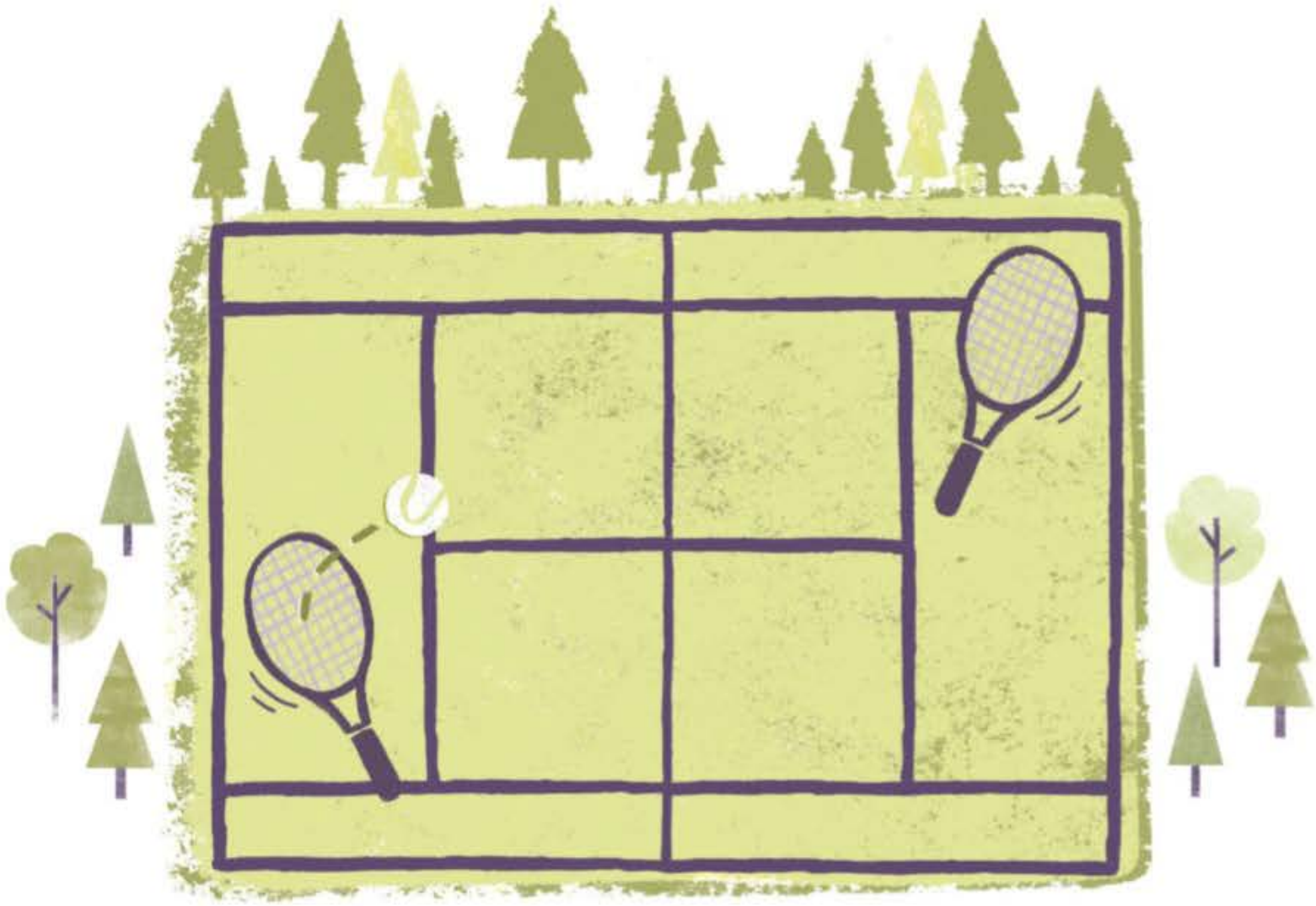

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UNFAO, Global Forest Resources Assessment 2005-2015

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